DESIGN OF AERIAL CABLE PLANT

Purpose: This addendum is issued to supplement Section 630 with revised and new information relative to the design of Central Office Entrance Cables where neither a cable vault nor a splicing trough exists.

Deletions: Paragraphs 6.01, 6.02, 6.03, 6.04, 6.05, 6.06, Figure 5 and Table I.

Additions: Add new Paragraphs 6.01, 6.02, 6.03, 6.04, 6.05, 6.06, 6.07, Figure 5, Table I and Table II.

6. CENTRAL OFFICE ENTRANCE CABLES

6.01 Entrance cables may be installed in the air, directly buried, or placed in underground conduit. The type of installation selected should depend on physical conditions and other circumstances. The engineer should prepare detailed plans for this construction. Where clearance and appearance conditions are not controlling factors, aerial type entries should be satisfactory. However, if an underground entrance is required, cable may be buried directly in the ground or placed in underground conduit.

6.02 Where direct burial entrance is preferable, cables manufactured to REA Specification PE-39, "Filled Telephone Cable", should be specified, unless the direct buried cable is to be pressurized, then cables manufactured to REA Specification PE-23 should be used for this application.

6.03 Where an underground conduit entrance is selected, nonpressurized entrance cables should meet REA Specification PE-39 and pressurized entrance cables should meet REA Specification PE-22.

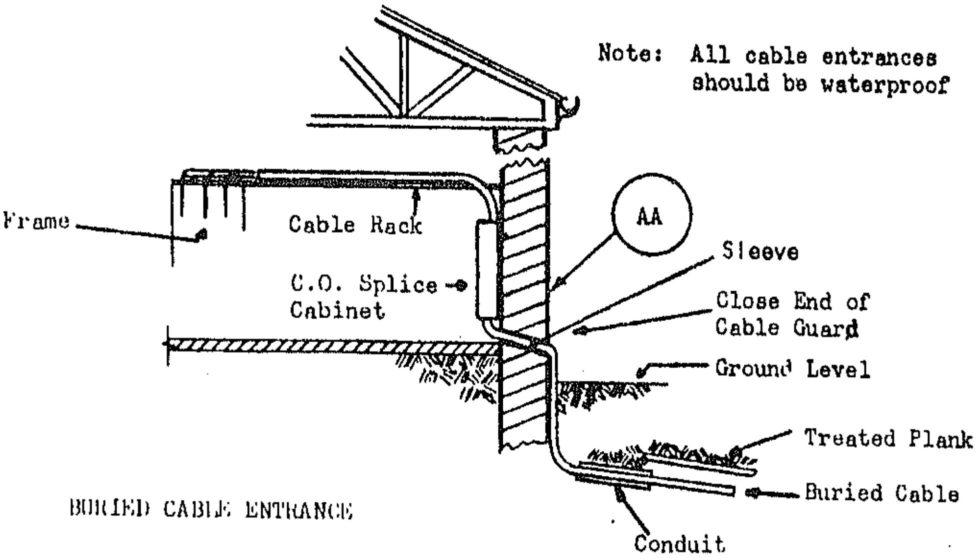
6.04 Figures 3, 4, 5 and 6 illustrate some problems involved in engineering a central office entrance. In the future, as a fire safety precaution, B type main distribution frames, which terminate the entrance cables on the vertically mounted protectors, should be spliced with PVC jacketed tip cables (refer to TE&CM 810, paragraph 2.4). These tip cables must also be spliced to the entrance cables, either above the frame, in the splicing vault under the floor, or in a wall mounted metal cabinet. The engineer should select the method.

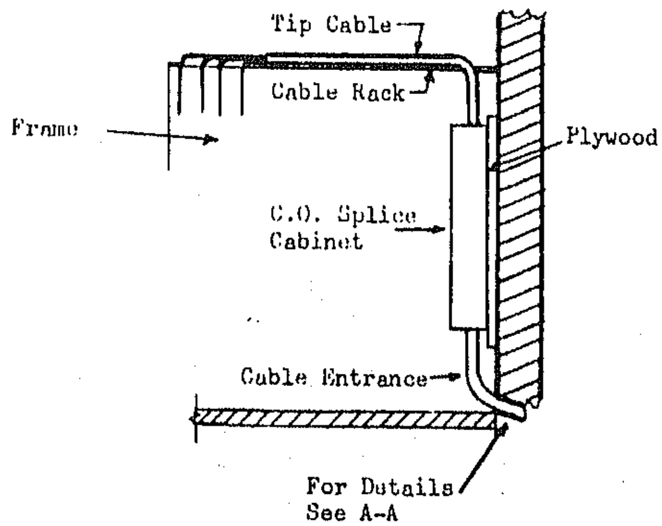
6.05 In the event that neither a cable vault nor a splicing trough exists, the new entrance cable should be routed to the building to enter at a point as close as practicable to the main frame. The entrance cable should enter through the wall into a cabinet mounted on the inside of the wall near the main frame. The entrance cable should be spliced within the cabinet to the PVC jacketed type tip cable which would be routed through the top of the cabinet and run directly overhead to the main frame. This type entrance is relatively inexpensive, provides good accessibility for checking shield bonding and makes it easy to bring in more cables in the future.

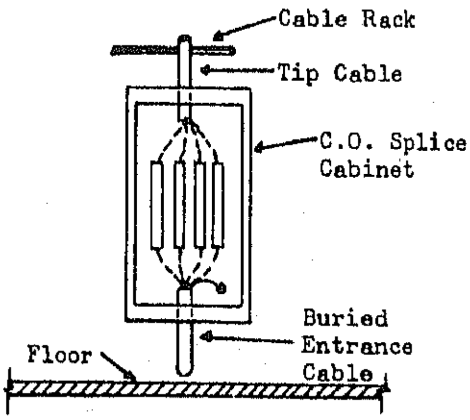
6.06 Where underground conduit entrances are planned, reference can be made to REA TE&CM 643 for details of such construction.

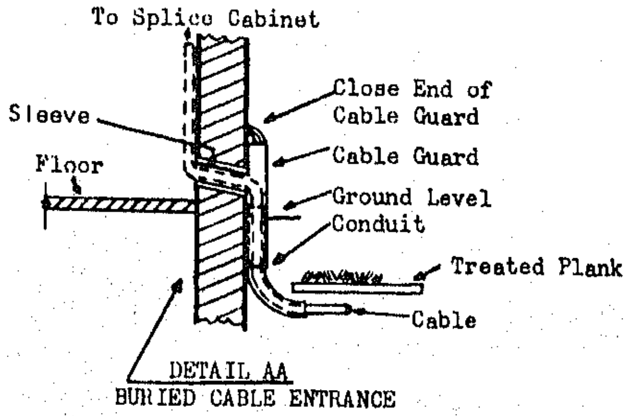
6.07 For description of the assembly unit covering the central office cable entrance, refer to the appropriate specifications in the REA Form 511.

CENTRAL OFFICE BURIED CABLE ENTRANCE









SLEEVES
Sleeve or hole in wall shal be of proper size as needed to accommodate cable. See Table I for size and diameter of cables.
Entrance above ground pl... sleeve, or cut hole to t... cable
Sleeve may be of galvanized pipe, plastic duct, clay duct or sewer tile.

Figure 5

CABLE SIZES, WEIGHTS AND REEL LENGTHS PE-22

PLASTIC SHEATHED AND PLASTIC INSULATED CABLES (AIR CORE)*

Number of Pairs	Approx. Diameter and Weight per Unit Length								Approx. Reel Length			
	26 Gauge		24 Gauge		22 Gauge		19 Gauge		26 Gauge	24 Gauge	22 Gauge	19 Gauge
	in.	lb/ft	in.	lb/ft	in.	lb/ft	in.	lb/ft	FEET	FEET	FEET	FEET
6	--	--	0.37	0.055	0.40	0.073	0.51	0.11	---	5000	5000	2500
12	--	--	0.44	0.086	0.49	0.11	0.62	0.18	---	10000	10000	2500
18	--	--	0.47	0.11	0.56	0.15	0.73	0.26	---	10000	10000	2500
25	0.46	0.098	0.53	0.14	0.63	0.20	0.82	0.34	10000	5000	5000	2500
50	0.57	0.16	0.68	0.24	0.80	0.34	1.10	0.63	10000	5000	5000	2500
75	0.65	0.22	0.77	0.33	0.94	0.50	1.29	0.90	5000	5000	5000	2500
100	0.72	0.28	0.85	0.42	1.07	0.61	1.47	1.18	5000	5000	2500	1200
150	0.86	0.41	1.03	0.60	1.28	0.92	1.80	1.75	5000	2500	2500	1200
200	0.96	0.52	1.21	0.82	1.45	1.22	2.03	2.26	2500	2500	1200	1200
300	1.13	0.75	1.43	1.14	1.74	1.78	2.47	3.42	2500	2500	1200	1200
400	1.26	0.97	1.59	1.49	1.98	2.32	2.82	4.47	1200	1200	1200	1200
600	1.52	1.42	1.93	2.20	2.44	3.49	--	--	1200	1200	1200	--
900	1.83	2.04	2.37	3.29	--	--	--	--	1200	1200	--	--
1200	2.13	2.74	2.86	4.42	--	--	--	--	1200	1200	--	--
1500	2.36	3.36	2.95	5.42	--	--	--	--	1200	1200	--	--
1800	2.56	4.01	3.19	6.46	--	--	--	--	1200	750	--	--
	cm.	kg/m	cm.	kg/m	cm.	kg/m	cm.	kg/m	METERS	METERS	METERS	METERS
6	--	--	0.94	0.08	1.02	0.11	1.30	0.16	--	1524	1524	762
12	--	--	1.12	0.13	1.24	0.16	1.57	0.27	--	3048	3048	762
18	--	--	1.19	0.16	1.42	0.22	1.85	0.39	--	3048	3048	762
25	1.17	0.15	1.35	0.21	1.60	0.30	2.08	0.51	3048	1524	1524	762
50	1.45	0.24	1.73	0.36	2.03	0.51	2.79	0.94	3048	1524	1524	762
75	1.65	0.38	1.96	0.49	2.39	0.74	3.28	1.34	1524	1524	1524	762
100	1.83	0.42	2.16	0.63	2.72	0.91	3.73	1.76	1524	1524	762	366
150	2.18	0.61	2.62	0.89	3.25	1.37	4.57	2.60	1524	762	762	366
200	2.44	0.77	3.07	1.22	3.68	1.82	5.16	3.36	762	762	366	366
300	2.87	1.12	3.63	1.70	4.42	2.65	6.27	5.09	762	762	366	366
400	3.20	1.44	4.04	2.22	5.03	3.45	7.16	6.65	366	366	366	366
600	3.86	2.11	4.90	3.27	6.20	5.19	--	--	366	366	366	--
900	4.65	3.04	6.02	4.90	--	--	--	--	366	366	--	--
1200	5.41	4.08	7.26	6.58	--	--	--	--	366	366	--	--
1500	5.99	5.00	7.49	8.07	--	--	--	--	366	366	--	--
1800	6.50	5.97	8.10	9.61	--	--	--	--	366	229	--	--

*Shield: .008 inch coated aluminum

TABLE I

CABLE SIZES, WEIG. AND REEL LENGTHS PE-39

PLASTIC SHEATHED AND PLASTIC INSULATED CABLE (FILLED CORE)*

Number of Pairs	Approx. Diameter and Weight Per Unit Length								Approx. Reel Length			
	26 Gauge		24 Gauge		22 Gauge		19 Gauge		26 Gauge	24 Gauge	22 Gauge	19 Gauge
	in.	lb/ft	in.	lb/ft	in.	lb/ft	in.	lb/ft	FEET	FEET	FEET	FEET
6	--	--	0.41	0.078	0.44	0.092	0.51	0.15	--	5000	5000	5000
12	--	--	0.49	0.11	0.54	0.14	0.71	0.25	--	5000	5000	5000
18	--	--	0.53	0.14	0.63	0.20	0.82	0.35	--	5000	5000	2500
25	0.50	0.12	0.61	0.18	0.70	0.26	0.92	0.47	5000	5000	5000	2500
50	0.62	0.20	0.76	0.32	0.90	0.45	1.29	0.87	5000	5000	5000	2500
75	0.70	0.23	0.88	0.43	1.09	0.66	1.57	1.30	5000	5000	5000	2500
100	0.77	0.34	0.99	0.56	1.22	0.84	1.73	1.63	5000	2500	2500	2500
150	0.93	0.50	1.19	0.81	1.48	1.25	2.09	2.42	2500	2500	2500	1250
200	1.08	0.67	1.44	1.42	1.66	1.61	2.37	3.20	2500	2500	2500	1250
300	1.26	0.93	1.62	1.55	2.01	2.37	2.79	4.60	1250	2500	2500	1250
400	1.43	1.22	1.86	2.04	2.30	3.18	--	--	1250	1250	1250	--
600	1.74	1.81	2.29	3.06	2.81	4.63	--	--	1250	1250	1250	--
900	2.05	2.61	2.75	4.49	--	--	--	--	1250	1200	--	--
1200	2.34	3.42	--	--	--	--	--	--	1250	--	--	--
	cm.	kg/m	cm.	kg/m	cm.	kg/m	cm.	kg/m	METERS	METERS	METERS	METERS
6	--	--	1.04	0.12	1.12	0.14	1.30	0.22	--	1524	1524	1524
12	--	--	1.24	0.16	1.37	0.21	1.80	0.37	--	1524	1524	1524
18	--	--	1.35	0.21	1.60	0.30	2.08	0.52	--	1524	1524	762
25	1.27	0.18	1.55	0.27	1.78	0.39	2.34	0.70	1524	1524	1524	762
50	1.57	0.30	1.93	0.48	2.29	0.67	3.28	1.29	1524	1524	1524	762
75	1.78	0.34	2.24	0.64	2.77	0.98	3.99	1.93	1524	1524	1524	762
100	1.96	0.51	2.51	0.83	3.10	1.25	4.39	2.43	1524	762	762	762
150	2.36	0.74	3.02	1.21	3.76	1.86	5.31	3.60	762	762	762	381
200	2.74	1.00	3.66	2.11	4.22	2.40	6.02	4.76	762	762	762	381
300	3.20	1.38	4.11	2.31	5.11	3.53	7.09	6.85	381	762	762	381
400	3.63	1.82	4.72	3.04	5.84	4.73	--	--	381	381	381	--
600	4.42	2.69	5.82	4.55	7.14	6.89	--	--	381	381	381	--
900	5.21	3.88	6.99	6.68	--	--	--	--	381	366	--	--
1200	5.94	5.09	--	--	--	--	--	--	381	--	--	--

*Shield: .008 inch coated aluminum

DESIGN OF AERIAL CABLE PLANT

Purpose: This addendum is issued to: (1) revise the graphs showing the final unloaded sags to be used in the design of Figure 8 cable plant to reflect the latest interpretation of the National Electrical Safety Code, (2) reflect the revision of PE-38, REA Specification for Figure 8 cable, by providing sag data for cable with a 3/16-inch, 7-wire strand EHS integral support messenger to replace the sag data provided previously for cable with a 0.148-inch solid integral support messenger. It replaces Addendum No. 1.

Additions:

1. GENERAL

1.04 Basically the same design requirements apply for non-joint Figure 8 cable as for non-joint lashed polyethylene-insulated (PIC) cable except for the additional information presented in this addendum.

1.05 The information included in this addendum pertains specifically to the following cables meeting REA Specification PE-38:

3/16-inch EHS Support Strand Pair/Gauge	1/4-inch EHS Support Strand Pair/Gauge
6/19	25/19
12/19	50/19
18/19	75/19
6/22	50/22
12/22	100/22
18/22	75/24
25/22	100/24
6/24	150/24
12/24	200/24
18/24	
25/24	
50/24	

2. ECONOMIC AND SERVICE FACTORS

2.15 Figure 8 cable consists of individually insulated copper conductors twisted into pairs. The required number of twisted pairs are stranded into a cable core and enclosed in an aluminum shield. The shielded assembly is covered by an extruded polyethylene jacket with a parallel integral support strand. The integral messenger eliminates the need for lashing wire or rings.

2.16 Figure 8 cable to be used in projects of REA borrowers should meet the requirements of REA Specification PE-38. This specification provides for cables having 19, 22, or 24 gauge conductors, all conductors of each cable being of the same gauge. Composite cables (cables containing standard complements of 19 and 22 gauge pairs) can also be obtained under this specification. Two types of support messengers are available depending on the size cable desired. Either 3/16-inch EHS galvanized steel 7-wire stranded support messenger or a 1/4-inch EHS galvanized steel 7-wire stranded support messenger will be used.

4. SUSPENSION STRAND SELECTION

4.06 The support strand is an integral part of the Figure 8 cable and is supplied with the standard cable sizes specified in REA Specification PE-38.

4.07 Figure 8 cables are not suitable for supporting a man on either a cable car or a ladder. No supplementary cables should be lashed to a Figure 8 cable.

5. SPAN LENGTHS

5.09 The maximum span lengths to be used with Figure 8 cables of various sizes and gauges are given in sag charts 10a through 15a. These maximum span lengths are calculated on the basis of not exceeding 60% of the breaking strength of the support messenger under Fourth Edition NESC assumed storm loading. These charts indicate the pole height required for a 14-foot final unloaded ground clearance of 60°F. The pole class required is determined from REA TE & CM 611, "Design of Pole Lines," using the equivalent number of wires shown for the various sizes of Figure 8 cable.

5.10 Curves giving final unloaded sags at 60°F. are included in the following figures:

			NESC Assumed Loading*	
Figure	District	Support Messenger Size	Horizontal Wind Pressure (lbs/sq. ft.)	Radical Thickness of Ice (Inch)
10a	Heavy	3/16"	8	0.50
11a	Medium	3/16"	8	0.25
12a	Light	3/16"	12	0
13a	Heavy	1/4"	8	0.50
14a	Medium	1/4"	8	0.25
15a	Light	1/4"	12	0

*The Fourth Edition of the National Electrical Safety Code made relatively severe assumptions concerning transverse loading with the result that the pole strengths necessary were considerably out of line with designs using the same materials in other fields of engineering. Studies made since its issuance indicated that the wind pressures assumed for transverse loading seldom occur concurrently with the assumed ice conditions and then only in restricted areas. The Fifth and Sixth Editions of the Code reduced this assumed transverse wind loading. Therefore, constants were added to the resultant loading calculated in accordance with these editions to make the loading in the Fourth, Fifth and Sixth Editions effectively equivalent for round conductors.

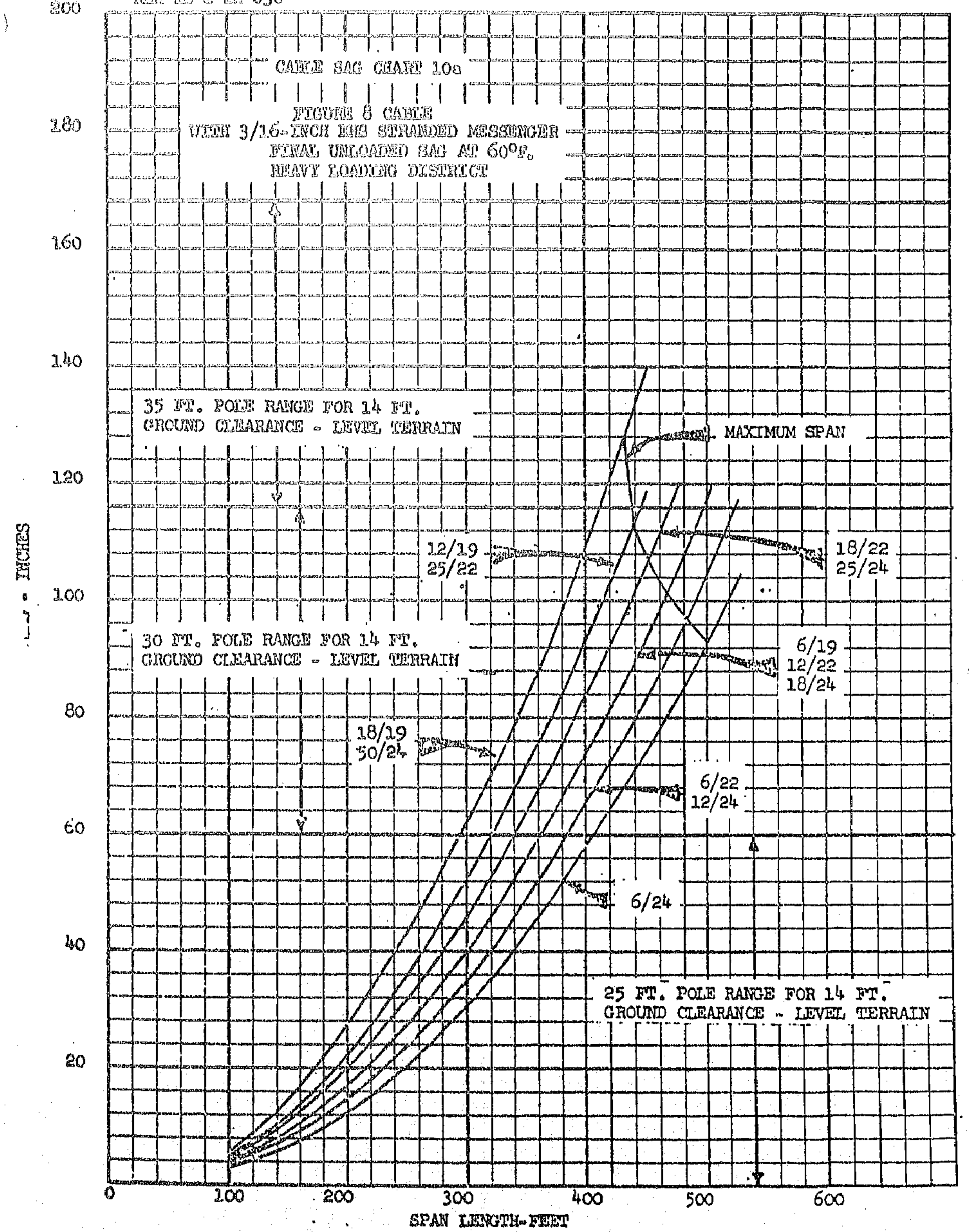
Figure 8 cable does not develop the same amount of loading as would be developed by a single round conductor. The Sixth Edition of the NESC requires that a "double constant" be added to the calculated resultant load. This addition represents a substantial over-design for Figure 8 cable. For sag and tension purposes, the NESC Committee on Interpretations has permitted Figure 8 facilities to have loads calculated in accordance with the Fourth Edition.

Transverse loads for pole strength are calculated according to the assumptions in the Sixth Edition.

5.11 The following three examples are offered to illustrate the proper use of cable sag charts 10a through 15a.

Example 1: Assume a 50 pair, 19 gauge Figure 8 cable is to be used in the light loading district. A 14-foot final unloaded ground clearance is required and the terrain is level. What is the maximum span length allowable if 25-foot poles are used: From Cable Sag Chart 15a, the maximum span allowable is 275 feet.

Example 2: A 75 pair, 22 gauge cable is to be used in the medium loading district for a road crossing requiring 18.5 feet of final unloaded sag. The span length is 300 feet. What size poles are required? From Cable Sag Chart 14a, a 25-foot pole would be required for a 14-foot ground clearance. However, since we need 54 more inches, the equivalent sag for the 75/22 Figure 8 cable would be 60" + 54" = 114". The 114" places the pole length between 25' and 30'. Select two 30-foot poles to assure a ground clearance of 18.5 feet at midspan. From REA TE & CM 611, we would find that class 7 poles would be required.


CABLE SAG CHART 10a
FIGURE 8 CABLE
WITH 3/16-INCH EHS STRANDED MESSENGER
FINAL UNLOADED SAG AT 60°F.
HEAVY LOADING DISTRICT
35 FT. POLE RANGE FOR 14 FT.
GROUND CLEARANCE - LEVEL TERRAIN
30 FT. POLE RANGE FOR 14 FT.
GROUND CLEARANCE - LEVEL TERRAIN
25 FT. POLE RANGE FOR 14 FT.
GROUND CLEARANCE - LEVEL TERRAIN
MAXIMUM SPAN
12/19
25/22
18/22
25/24
6/19
12/22
18/24
18/19
30/24
6/22
12/24
6/24
200
180
160
140
120
100
80
60
40
20
0
100
200
300
400
500
600
SAG - INCHES
SPAN LENGTH-FEET

4.07 Figure 8 cables are not suitable for supporting a man on either a cable car or a ladder. No supplementary cables should be lashed to a Figure 8 cable.

5. SPAN LENGTHS

5.09 The maximum span lengths to be used with Figure 8 cables of various sizes and gauges are given in sag charts 10a through 15a. These maximum span lengths are calculated on the basis of not exceeding 60% of the breaking strength of the support messenger under Fourth Edition NESC assumed storm loading. These charts indicate the pole height required for a 14-foot final unloaded ground clearance of 60°F. The pole class required is determined from REA TE & CM 611, "Design of Pole Lines," using the equivalent number of wires shown for the various sizes of Figure 8 cable.

5.10 Curves giving final unloaded sags at 60°F. are included in the following figures:

Figure	District	Support Messenger Size	NESC Assumed Loading* Horizontal Wind Pressure (lbs/sq. ft.)	Radical Thickness of Ice (Inch)
10a	Heavy	3/16"	8	0.50
11a	Medium	3/16"	8	0.25
12a	Light	3/16"	12	0
13a	Heavy	1/4"	8	0.50
14a	Medium	1/4"	8	0.25
15a	Light	1/4"	12	0

*The Fourth Edition of the National Electrical Safety Code made relatively severe assumptions concerning transverse loading with the result that the pole strengths necessary were considerably out of line with designs using the same materials in other fields of engineering. Studies made since its issuance indicated that the wind pressures assumed for transverse loading seldom occur concurrently with the assumed ice conditions and then only in restricted areas. The Fifth and Sixth Editions of the Code reduced this assumed transverse wind loading. Therefore, constants were added to the resultant loading calculated in accordance with these editions to make the loading in the Fourth, Fifth and Sixth Editions effectively equivalent for round conductors.

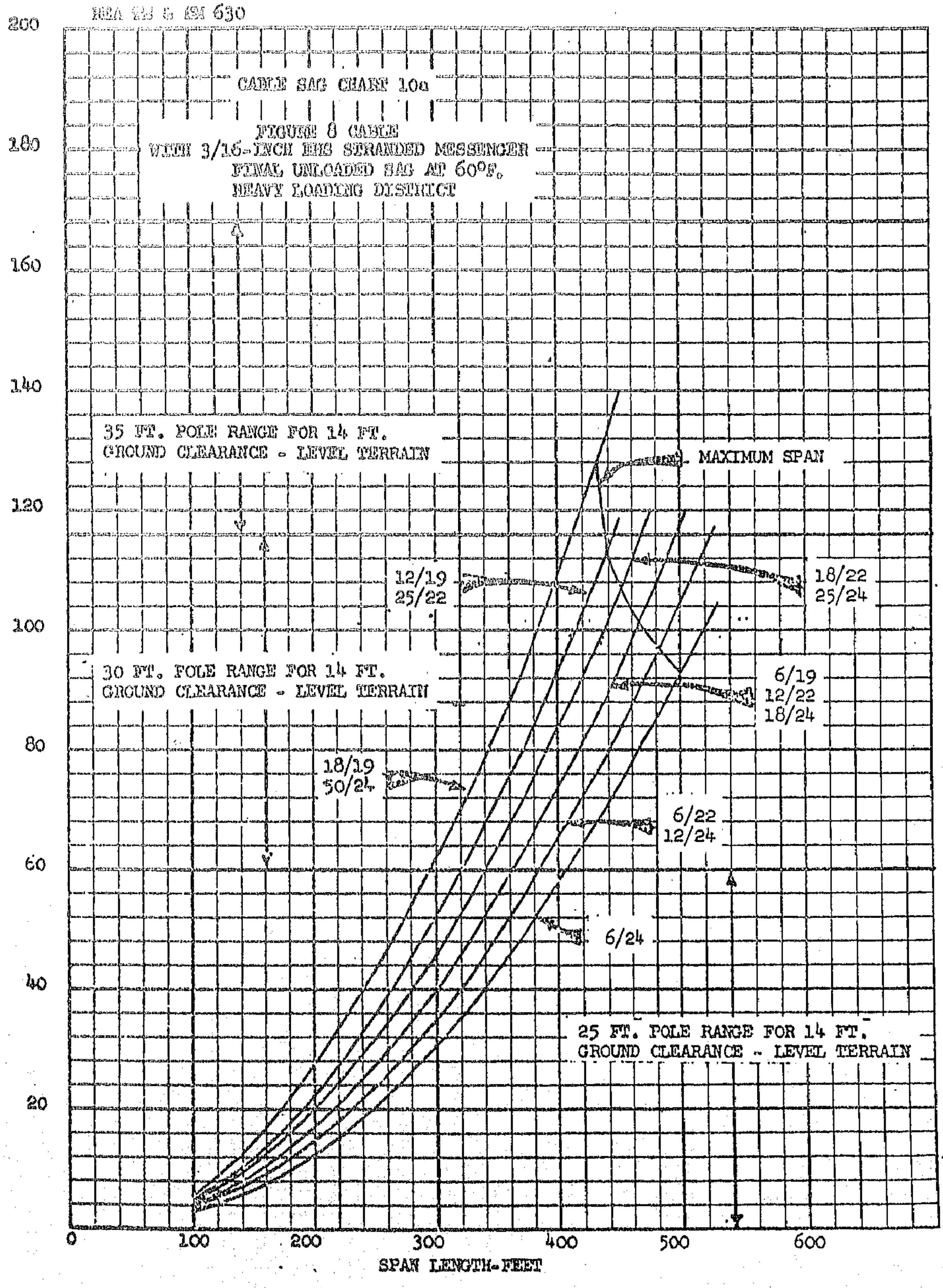
Figure 8 cable does not develop the same amount of loading as would be developed by a single round conductor. The Sixth Edition of the NESC requires that a "double constant" be added to the calculated resultant load. This addition represents a substantial over-design for Figure 8 cable. For sag and tension purposes, the NESC Committee on Interpretations has permitted Figure 8 facilities to have loads calculated in accordance with the Fourth Edition.

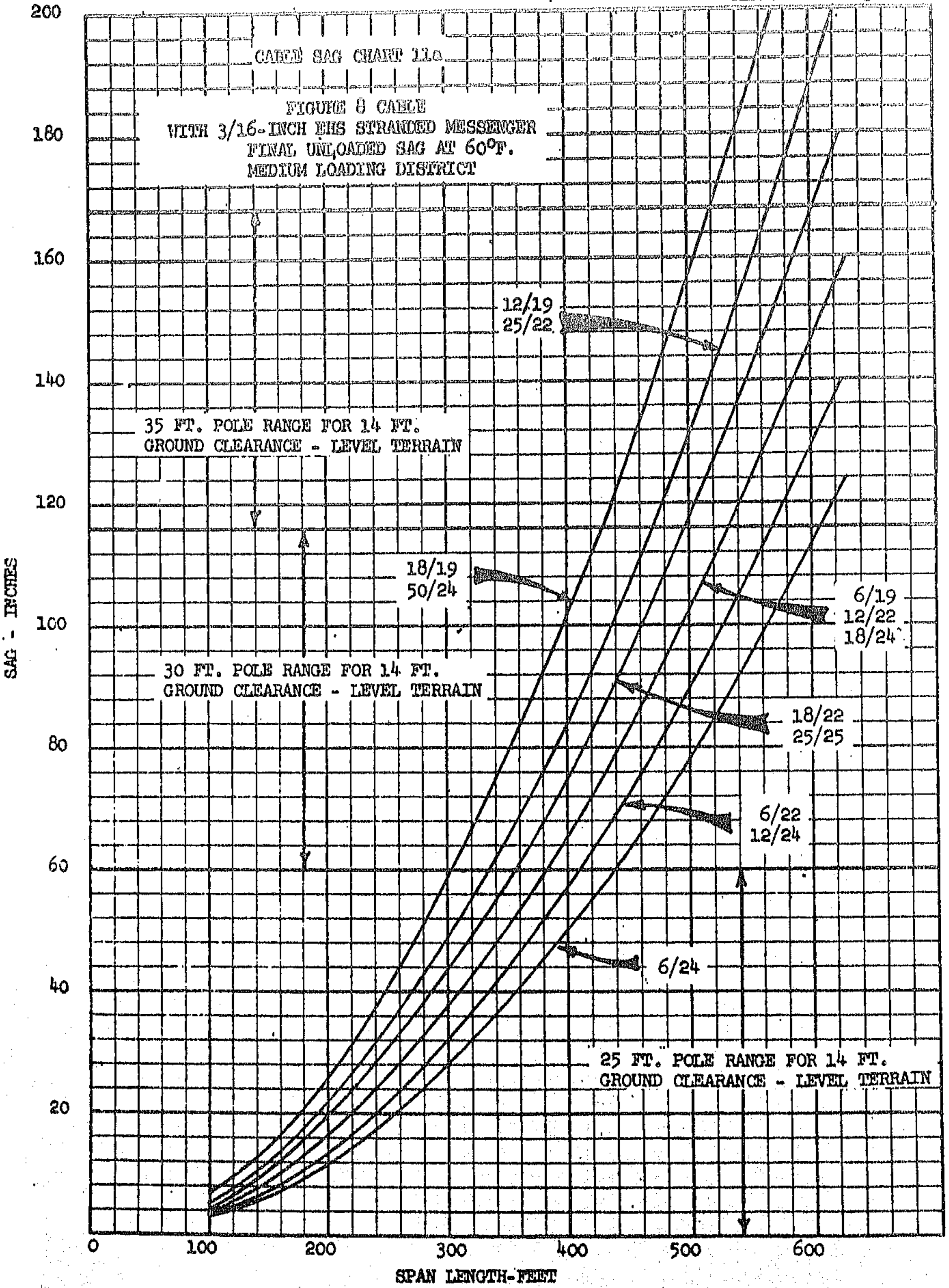
Transverse loads for pole strength are calculated according to the assumptions in the Sixth Edition.

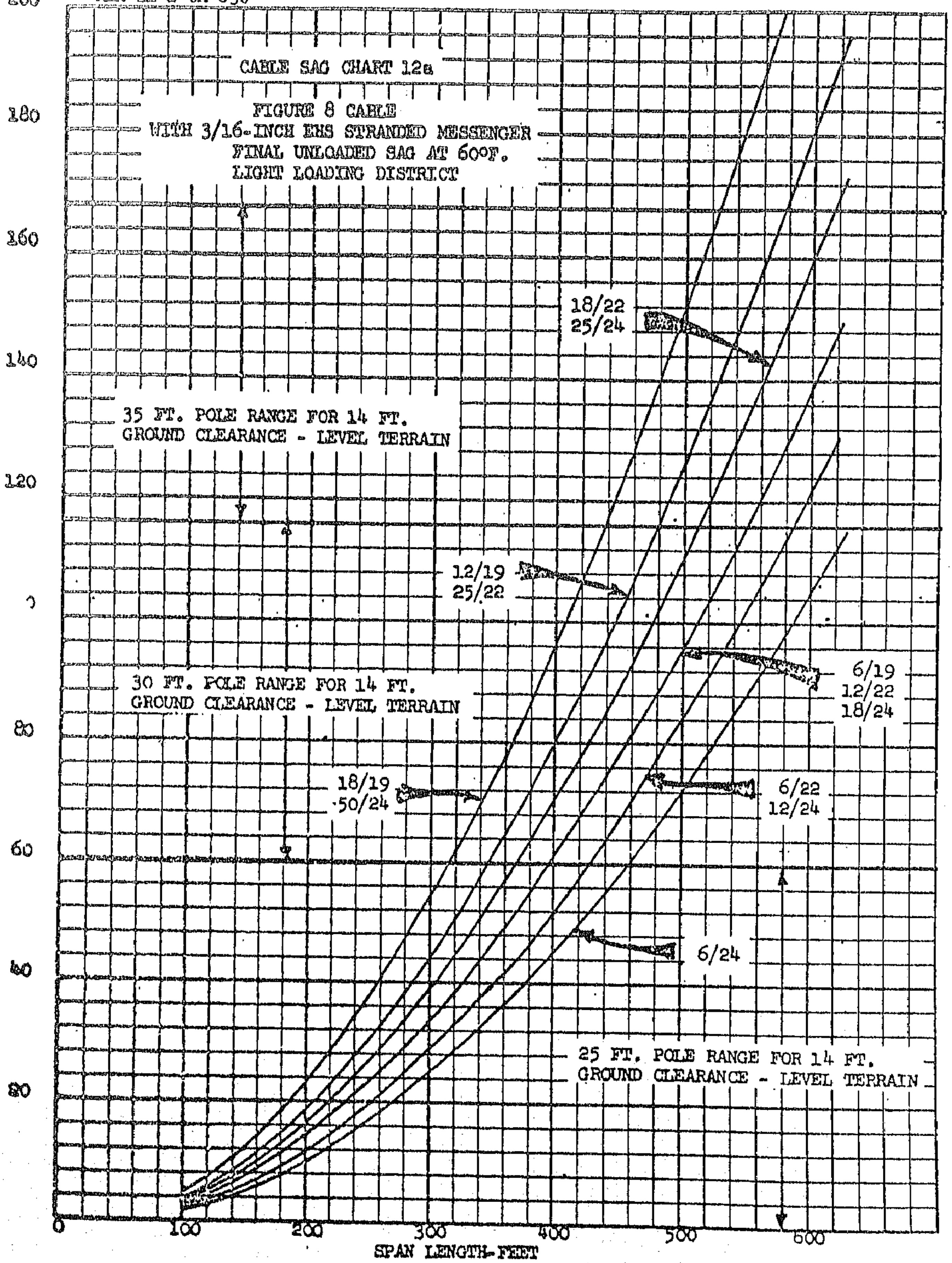
5.11 The following three examples are offered to illustrate the proper use of cable sag charts 10a through 15a.

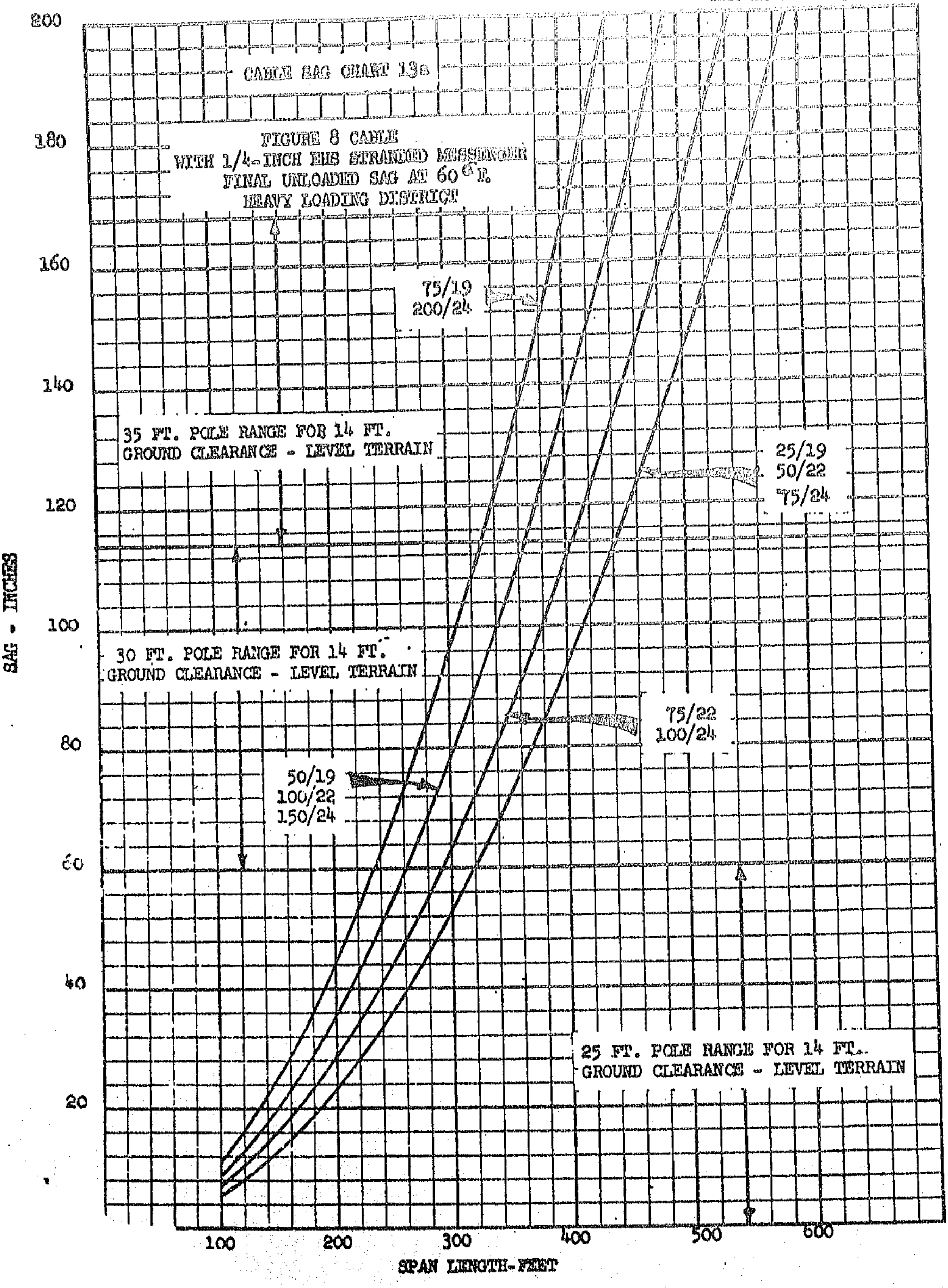
Example 1: Assume a 50 pair, 19 gauge Figure 8 cable is to be used in the light loading district. A 14-foot final unloaded ground clearance is required and the terrain is level. What is the maximum span length allowable if 25-foot poles are used: From Cable Sag Chart 15a, the maximum span allowable is 275 feet.

Example 2: A 75 pair, 22 gauge cable is to be used in the medium loading district for a road crossing requiring 18.5 feet of final unloaded sag. The span length is 300 feet. What size poles are required? From Cable Sag Chart 14a, a 25-foot pole would be required for a 14-foot ground clearance. However, since we need 54 more inches, the equivalent sag for the 75/22 Figure 8 cable would be 60" + 54" = 114". The 114" places the pole length between 25' and 30'. Select two 30-foot poles to assure a ground clearance of 18.5 feet at midspan. From REA TE & CM 611, we would find that class 7 poles would be required.

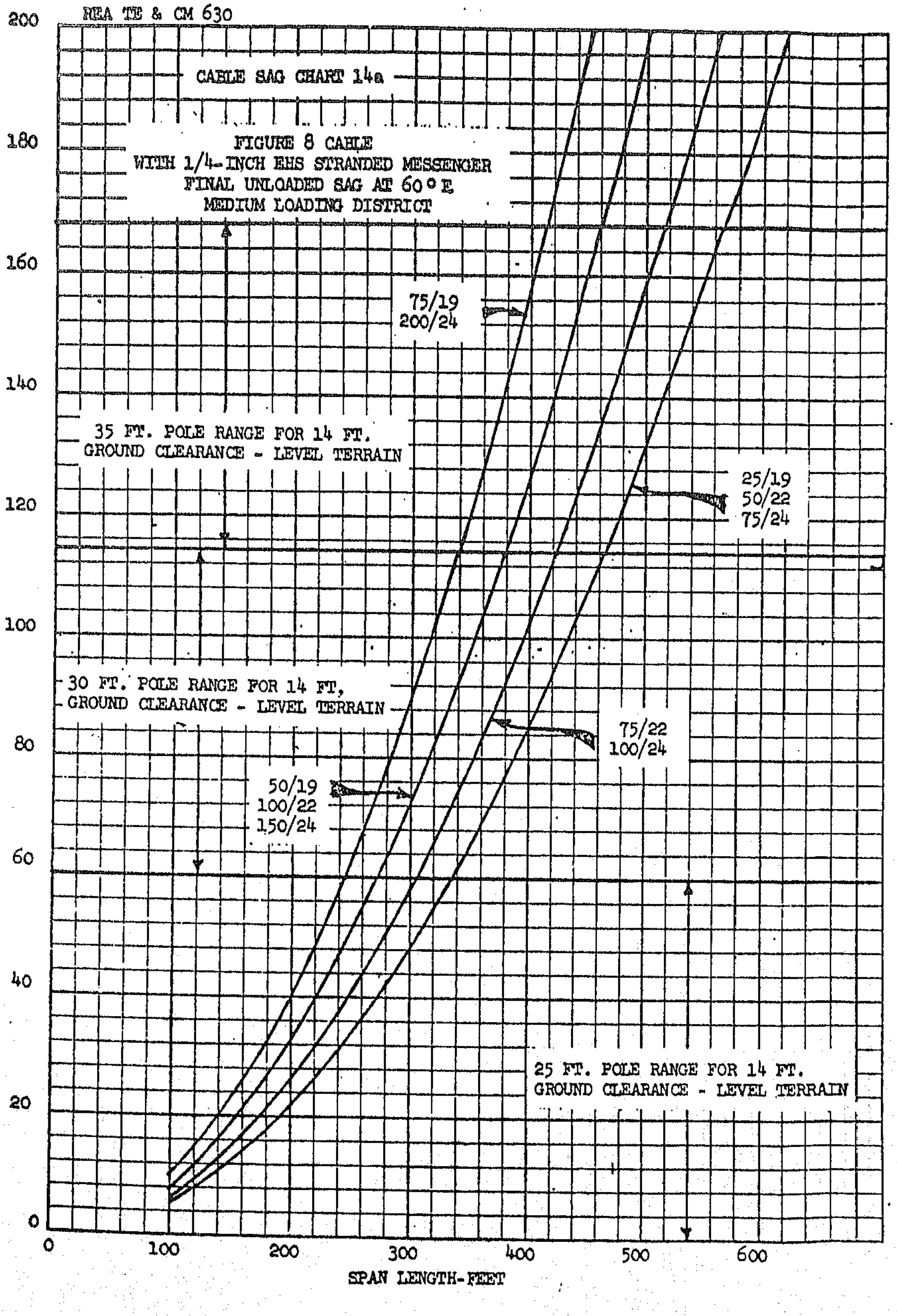

CABLE SAG CHART 10a
FIGURE 8 CABLE
WITH 3/16-INCH EHS STRANDED MESSENGER
FINAL UNLOADED SAG AT 60°F.
HEAVY LOADING DISTRICT
35 FT. POLE RANGE FOR 14 FT.
GROUND CLEARANCE - LEVEL TERRAIN
30 FT. POLE RANGE FOR 14 FT.
GROUND CLEARANCE - LEVEL TERRAIN
25 FT. POLE RANGE FOR 14 FT.
GROUND CLEARANCE - LEVEL TERRAIN
MAXIMUM SPAN
12/19
25/22
18/22
25/24
6/19
12/22
18/24
18/19
50/24
6/22
12/24
6/24
SAG - INCHES
SPAN LENGTH-FEET
0
100
200
300
400
500
600
20
40
60
80
100
120
140
160
180
200

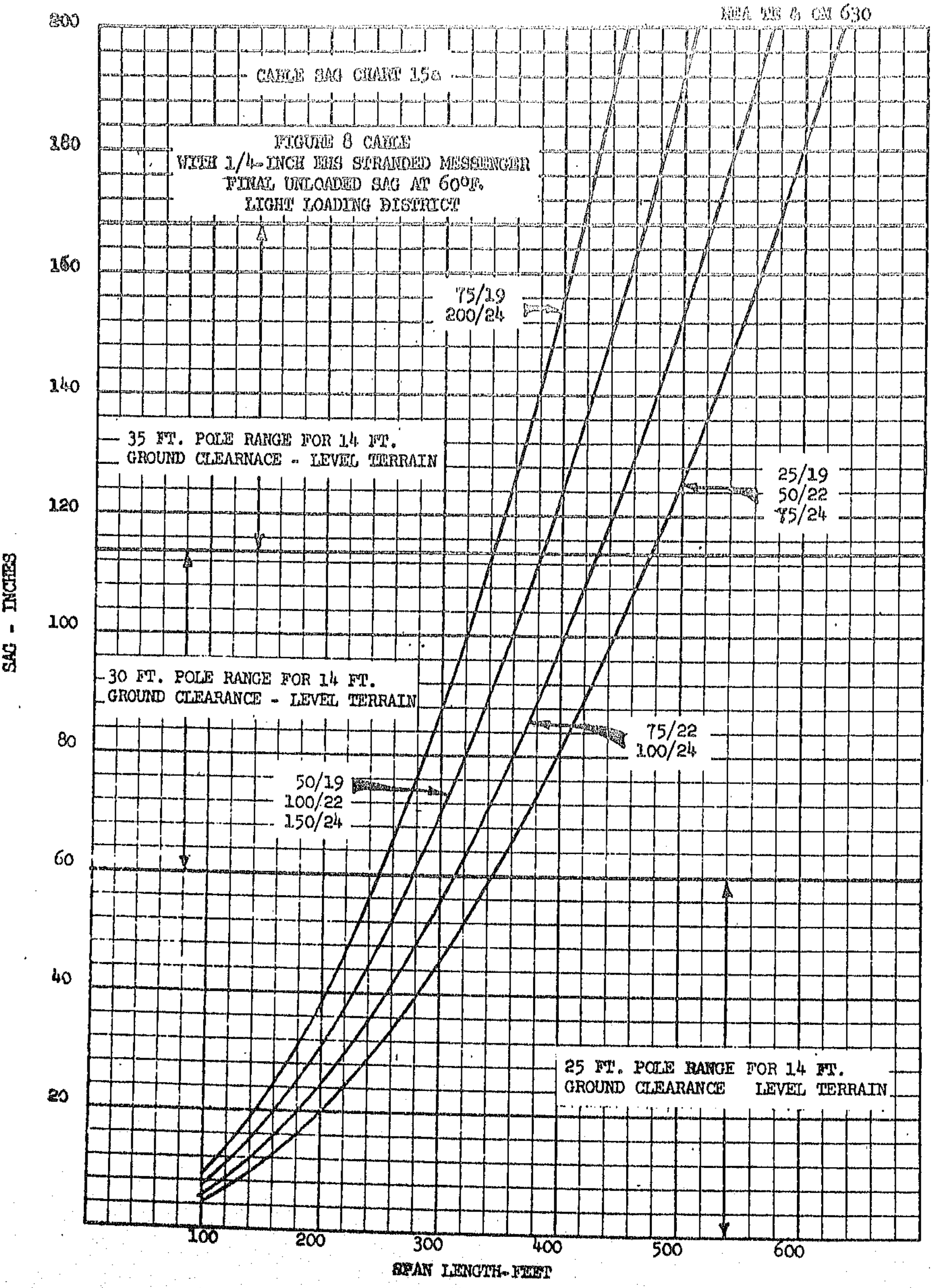

CABLE SAG CHART 11a
FIGURE 8 CABLE
WITH 3/16-INCH EHS STRANDED MESSENGER
FINAL UNLOADED SAG AT 60°F.
MEDIUM LOADING DISTRICT
12/19
25/22
18/19
50/24
6/19
12/22
18/24
18/22
25/25
6/22
12/24
6/24
35 FT. POLE RANGE FOR 14 FT.
GROUND CLEARANCE - LEVEL TERRAIN
30 FT. POLE RANGE FOR 14 FT.
GROUND CLEARANCE - LEVEL TERRAIN
25 FT. POLE RANGE FOR 14 FT.
GROUND CLEARANCE - LEVEL TERRAIN
SAG - INCHES
200
180
160
140
120
100
80
60
40
20
0
100
200
300
400
500
600
SPAN LENGTH-FEET


CABLE SAG CHART 12a
FIGURE 8 CABLE
WITH 3/16-INCH EHS STRANDED MESSENGER
FINAL UNLOADED SAG AT 60°F.
LIGHT LOADING DISTRICT
35 FT. POLE RANGE FOR 14 FT.
GROUND CLEARANCE - LEVEL TERRAIN
30 FT. POLE RANGE FOR 14 FT.
GROUND CLEARANCE - LEVEL TERRAIN
25 FT. POLE RANGE FOR 14 FT.
GROUND CLEARANCE - LEVEL TERRAIN
18/22
25/24
12/19
25/22
6/19
12/22
18/24
18/19
50/24
6/22
12/24
6/24
200
180
160
140
120
80
60
40
20
0
100
200
300
400
500
600
SPAN LENGTH-FEET


CABLE SAG CHART 13a
FIGURE 8 CABLE
WITH 1/4-INCH EHS STRANDED MESSENGER
FINAL UNLOADED SAG AT 60° F.
HEAVY LOADING DISTRICT
75/19
200/24
35 FT. POLE RANGE FOR 14 FT.
GROUND CLEARANCE - LEVEL TERRAIN
25/19
50/22
75/24
30 FT. POLE RANGE FOR 14 FT.
GROUND CLEARANCE - LEVEL TERRAIN
75/22
100/24
50/19
100/22
150/24
25 FT. POLE RANGE FOR 14 FT.
GROUND CLEARANCE - LEVEL TERRAIN
200
180
160
140
120
100
80
60
40
20
SAG - INCHES
100
200
300
400
500
600
SPAN LENGTH-FEET

REA TE & CM 630


CABLE SAG CHART 14a
FIGURE 8 CABLE
WITH 1/4-INCH EHS STRANDED MESSENGER
FINAL UNLOADED SAG AT 60° F
MEDIUM LOADING DISTRICT
35 FT. POLE RANGE FOR 14 FT.
GROUND CLEARANCE - LEVEL TERRAIN
30 FT. POLE RANGE FOR 14 FT.
GROUND CLEARANCE - LEVEL TERRAIN
25 FT. POLE RANGE FOR 14 FT.
GROUND CLEARANCE - LEVEL TERRAIN
75/19
200/24
25/19
50/22
75/24
75/22
100/24
50/19
100/22
150/24
0
20
40
60
80
100
120
140
160
180
200
0
100
200
300
400
500
600
SPAN LENGTH-FEET


CABLE SAG CHART 15a
FIGURE 8 CABLE
WITH 1/4-INCH EHS STRANDED MESSENGER
FINAL UNLOADED SAG AT 60°F.
LIGHT LOADING DISTRICT
75/19
200/24
35 FT. POLE RANGE FOR 14 FT.
GROUND CLEARNACE - LEVEL TERRAIN
25/19
50/22
75/24
30 FT. POLE RANGE FOR 14 FT.
GROUND CLEARANCE - LEVEL TERRAIN
75/22
100/24
50/19
100/22
150/24
25 FT. POLE RANGE FOR 14 FT.
GROUND CLEARANCE LEVEL TERRAIN
SAG - INCHES
SPAN LENGTH-FEET
200
180
160
140
120
100
80
60
40
20
100
200
300
400
500
600

DESIGN OF AERIAL CABLE PLANT

Contents

1. GENERAL

1.01 This section is intended to provide REA borrowers, consulting engineers, contractors and other interested parties with technical information for use in the design and construction of REA borrowers' telephone systems. It discusses in particular considerations in the design of nonjoint aerial cable plant.

1.02 This revision replaces REA TE & CM-630, Issue No. 2, dated June 1956. It incorporates designs using presently acceptable components for aerial cable plant constructed in accordance with the requirements of REA Form 511, "Telephone System Construction Contract."

1.03 The following REA publications are referred to in this section.

REA TE & CM Sections:

205 - Preparation of an Area Coverage Design
206 - Preparation of an Area Coverage Survey

REA TE & CM Sections (Cont'd):

210 - Telephone System Design Criteria - Engineering Time Periods
212 - Ringing Systems
218 - Plant Annual Cost Data for System Design Purposes
319 - Interoffice Trunking and Signaling
406 - Attenuation Data
415 - Transmission Objectives
422 - Subscriber Loop Transmission Calculations - Loop Loss Factor Method
423 Trunk Transmission Calculations
430 - Subscriber Line Loading
500 - Telephone Traffic
602 - Clearances
611 - Design of Pole Lines
617 - Railroad Crossing Specifications
626 - Staking
629 - Cable Plant Layout
635 - Construction of Aerial Cable Plant
636 - Aerial Cable Plant Assembly Units
643 - Underground Conduit Design and Construction
650 - Guys and Anchors on Wire and Cable Lines
670 - Corrosion Considerations in Outside Plant
815 - Cable Circuit Protection

REA Bulletins:

344-2 - List of Materials Acceptable for Use on Telephone Systems of REA Borrowers

REA Forms:

511 - Telephone System Construction Contract
525 - Central Office Equipment Contract

REA Specifications:

PC-1 - Splicing Standard for Joining Paper or Pulp-Insulated, Lead-Sheathed Cable to Paper or Pulp-Insulated Cable
PC-2 - Splicing and Terminating Plastic-Insulated, Plastic-Jacketed Cables Used on Telephone Systems of REA Borrowers
PE-22 - Fully Color-Coded, Polyethylene-Insulated, Polyethylene-Jacketed Telephone Cables
PE-23 - Fully Color-Coded Polyethylene-Insulated, Double Polyethylene-Jacketed Telephone Cables for Direct Burial

2. ECONOMIC AND SERVICE FACTORS

2.01 Aerial cable plant design presented herein is intended primarily for central offices serving small towns and their surrounding rural areas. At present polyethylene-insulated, polyethylene-jacketed cable is recommended by REA in preference to paper or pulp-insulated cable for new aerial cable plant for REA borrowers' telephone systems for the following reasons: it is available in the sizes (number of pairs) needed; it usually costs less in place than paper or pulp-insulated cable; it gives better service and lower maintenance costs because of its high dielectric strength and it is impervious to moisture; its color-coded conductors facilitate splicing, terminating and loading of the cable pairs; and its flexibility permits rearrangements to be made at minimum expense.

2.02 A most important consideration in the design of cable plant is the forecast of circuit requirements. This forecast is based on the area coverage design made in accordance with REA TE & CM-205. The engineer must balance flexibility and cost, keeping in mind the cost of future additions. This is especially necessary in cable plant, as the initial investment may be considerable.

2.03 The effective and economic design of cable plant depends upon the selection of the proper size (number of pairs), gauge and length of each different size of cable in a cable system and whether the construction should be aerial, in underground conduit or directly buried. The factors involved include the number of circuits required at present and in the future based on REA TE & CM-205, 206, 210, and 500; the transmission requirements at voice and carrier frequencies if carrier is required, based on data in REA TE & CM-406, 415, 422, and 423; the loop resistance limits (signaling range) for subscriber circuits required by the central office involved stated in REA TE & CM-212 and REA Form 525; the resistance limits for the trunks as given in REA TE & CM-319; and the suitability of the terrain for plowing cable into the ground. Underground conduit construction based on data in REA TE & CM-643 may be required for short distances in some situations.

2.04 Economic studies based on the area coverage survey and design should indicate the immediate (five-year) and expected (ten-year) service requirements. REA TE & CM-218 gives plant annual cost data.

2.05 Some subscribers may be located beyond the range of cable and some open wire will be necessary in lines for these subscribers. Loading of the cable in accordance with REA TE & CM-430 will increase the transmission range but will shorten the signaling range somewhat due to the resistance of the loading coils. Repeaters will not extend subscriber circuit signaling ranges. Long line adapters will extend the signaling ranges and will be required on subscriber circuits that exceed the loop resistance limits for the central office involved. Where distant subscribers require some open wire beyond the end of a cable the cable length must be such that its loop resistance plus the open wire loop resistance will not exceed the limits provided by long line adapters.

2.06 Investment in idle cable plant may make multipair distribution wire or open wire plant desirable. If cable is installed, generally it will be designed for both the immediate and ultimate requirements. However, if multipair distribution wire or open wire is used to meet the immediate needs, additional wire of these types may be added as needed to meet unforeseen requirements that may develop.

2.07 If the development of ultimate service requirements may point to an initial installation of multipair distribution wire or open wire which may have to be replaced with cable at a later date, the engineer must evaluate removal, salvage, transportation, and storage costs. It usually is not economical to salvage and restring line wire.

2.08 In some instances the realization of ultimate service forecasts or economy of one plan as compared to another may be in doubt. This should influence the postponement of cable installation until later, providing other factors are approximately equal.

2.09 Aerial cable to be used in new projects of REA borrowers, should meet the requirements of REA Specification PE-22. This specification provides for cables of various numbers of pairs having 19, 22, or 24 gauge conductors, all conductors of each cable being of the same gauge. Composite cables (cables containing pairs of more than one gauge) also can be obtained under this specification. Composite cables usually are made on an individual design basis and may be more expensive than cables having all pairs of the same gauge.

2.10 Cable sizes larger than 400 pairs seldom will be required in REA borrowers' telephone systems but can be obtained up to 900 pairs if 24 gauge, 600 pairs if 22 gauge, and 400 pairs if 19 gauge. The thickness of the polyethylene insulation being greater than paper insulation restricts the numbers of pairs in cables of the usual maximum outside diameter. Cables requiring more pairs than stated above preferably should be paper-insulated, plastic-sheathed which are available in larger sizes. Cables of 26 gauge seldom should be specified in REA borrowers' systems because they are difficult to splice, and the cost differential between 24 and 26 gauges in the small sizes is minor, making 24 gauge preferable.

2.11 Situations will occur where the urban portion of a cable and its branches can be of a smaller gauge than is needed for its rural extension. The maximum nonloaded loop limit for 24 gauge cable for subscriber circuits is less than 3 miles. The urban portions may be 24 gauge and the rural extensions either 22 or 19 gauge, or the urban portions may be 22 gauge and the rural extensions 19 gauge. Also, composite cables may be economical.

2.12 Short sections of aerial cable may be necessary or desirable in buried cable plant where rock formations prevent plowing; in urban areas where street pavement or sidewalks make it economical to utilize aerial cable; at stream crossings; at railroad crossings; in marshy terrain; and for central office entrances where clearance and appearance conditions are not controlling.

2.13 Period of cable fill is the length of elapsed time between service date of cable and the time it reaches maximum fill. The period in general should conform to the ten-year line requirements developed from the area coverage survey and design. In aerial feeder cables of the larger sizes (200 pairs or over), consideration should be given to the installation of the five-year requirements with reinforcement at a later date. The extra cost of such reinforcement at the later date may offset the added investment in idle cable facilities during the initial five-year period.

2.14 A large uniform size of cable with associated terminals, extending from the central office to the end of a cable line would result in a high degree of flexibility so that any unusual or unanticipated service demand along the cable could be met. However, the operating advantages realized from a

situation of this nature would be offset by idle plant investment resulting when the anticipated service forecasts do not materialize. Evaluation of these conditions can result in keeping idle cable plant investment to a reasonable minimum. Cable diminishing points should conform to the distribution of the expected growth along the cable and usually should be located at junctions of branch cables or where indicated by changes in subscriber density and rate of growth.

3. CABLE SELECTION

3.01 Prior to the staking of aerial cable plant, certain engineering decisions must be made in order to comply with requirements stated in various REA TE & CM sections mentioned herein, particularly REA TE & CM-629. The decisions include:

a. Cable size in number of pairs and gauge in each different section of the cable system.

b. The points of beginning and end of each section of cable of each size and gauge.

c. The approximate location of each terminal, the type of each terminal and the pair numbers to be terminated in each terminal other than the "Ready-Access" type.

d. The location of each loading point and the pair numbers to be loaded at each.

e. The type of central office cable entrance; that is, aerial, in conduit or buried.

f. Whether the central office entrance cable will be terminated directly on MFD protectors or spliced to tip cables and, if the latter, whether these splices shall be above the central office frames or in a splicing pit under the floor.

g. The type of terminal blocks (protected or unprotected) at each terminal.

h. Where the extra protection for Category III of REA TE & CM-815 is required (low impedance "made-grounds" and extra protectors).

i. Where joint use should be employed.

j. Where change in grade will require guying in accordance with Guide Drawing 213 in REA Form 511.

k. Where long span catenary construction will be necessary, with plans prepared for this work.

l. Where manholes, conduit, submarine or underground dips will be necessary, with plans prepared for these.

m. The normal in-span ground clearance of the strand and cable at 60°F. for every different section of the aerial cable system in accordance with REA TE & CM-602.

n. The basic span lengths for the different sizes of cable in the non-joint sections of the lines.

o. The basic pole heights for the different non-joint sections of line calculated from the basic ground clearances and the final unloaded sags of the suspension strand and cable, usually at 60°F.

p. The basic pole class for each section of non-joint line.

q. The suspension strand size for each section of the cable plant.

3.02 The staking engineer must be provided with maps showing the approximate beginning and end of each section of the cable of the various sizes, also showing the approximate location of each terminal and loading point and where each joint-use section shall begin and end. The map must show the locations of manholes where adjacent deadend poles will be required for underground cable to emerge as aerial cable or where buried cable is to emerge as aerial cable. The pole classes required for cables are determined in accordance with REA TE & CM-611 after the basic span lengths have been determined.

The staking notes will indicate the poles that require guys and the corner angles and permissible lead-over-height ratios. The guy and anchor selections shall be made by the engineer in accordance with the requirements of REA TE & CM-650 after the staking is completed, and this information shall be indicated on the staking sheets provided to the construction forces. The staking shall be done in accordance with the information provided in REA TE & CM-626.

3.03 The engineer will require sag and tension data for cables of various weights per foot, on strands of different sizes, for different span lengths and at various temperatures. Sag Charts 1 to 9, inclusive, herein provide final unloaded sags for various weights of cable on 6M, 10M, and 16M strands at 60°F. in the three storm loading districts for use in meeting the requirements of NESC ground clearances stated in REA TE & CM-602. The permissible span lengths indicated on the charts are based on the strands not exceeding 60 percent of their rated breaking strengths when the maximum storm loading is applied. These data provide information useful for long spans such as river crossings. Strand initial tensions for 6M, 10M, and 16M strands at various temperatures and for various span lengths are given in REA TE & CM-635.

4. SUSPENSION STRAND SELECTION

4.01 The suspension strand size for cable in REA borrowers' systems usually will be either 6M or 10M strand. The rated breaking strengths of these strands are 6,000 pounds and 11,500 pounds, respectively. ("Minimum breaking strength" is the same as "rated breaking strength.") Cable plant design is based on not exceeding 60 percent of the rated breaking strengths when the cable and strand are loaded as calculated according to the assumptions of wind, ice and temperature specified in the NESC for the storm loading district involved. The 16M strand would permit longer spans than the 10M strand but it is a rather large size as compared to the cable diameters usual for REA borrowers' telephone systems and is about 30 percent more costly than 10M strand. The 16M rated breaking strength is 18,000 pounds. It is not recommended for use with cables weighing less than 1.5 pounds per foot.

4.02 Utilities grade zinc coated strand is available in three zinc coating weights (Classes A, B, and C). Class A coated strand has 0.8 ounce of zinc per square foot of strand wire surface and is the commonly used strand, Class C coated strand which

has 2.4 ounces of zinc per square foot of strand wire surface should be considered where Class A coated strand would corrode excessively. In areas where the atmosphere may corrode Class C strand excessively, a flooded plastic coated strand or aluminum coated strand should be considered. Reference should be made to REA TE & CM-670 about corrosion problems.

4.03 Table 1 gives cable diameters, weights per foot and approximate reel lengths of three types of non-composite cable including plastic-insulated, plastic-sheathed cable made under REA Specification PE-22 and also similar data for lead-sheathed and plastic-sheathed paper or pulp-insulated cable.

4.04 Two cables can be lashed to the same strand. This may be desirable where an existing cable is in good condition but reinforcement is required by plant growth or extension. The combined diameters of the two cables cannot exceed the diameter for which the available lashing machine is designed. If the existing cable is in rings these can be taken off as the added cable is placed and the two cables are lashed to the strand. In order to promote firm lashing, the diameter of one cable should not be more than twice the diameter of the other cable. The existing cable can be lead-sheathed, and the added cable can be plastic-sheathed.

4.05 When a second cable is lashed to an existing cable, the sag will increase due to the weight of the added cable. The sag and tension data for a cable approximating the combined weights on the particular strand and for the average spans involved should be consulted to determine that the strand will not be overloaded or the resulting ground clearance insufficient.

5. SPAN LENGTHS

5.01 The Sag Charts 1 to 9 inclusive, show the span limits for poles of various lengths on level ground which will provide 14 foot final unloaded ground clearance at 60°F. for the cables of various weights on the 6M, 10M, and 16M strands. Cost studies have been made which indicate that 30 foot Class 7 poles for cable only, that is, no crossarms or distribution wire, are strong enough to provide the spans at lowest cost; also that the smallest strand permissible is the cheapest for any particular size of cable. The 30 foot poles have an advantage over 25 foot poles in providing greater height for drop wire road crossings.

5.02 The following problem describes a method for span length selection. Assume a 25 pair, 22 gauge plastic-insulated, plastic-sheathed cable is to be placed in the heavy storm loading district. Table 1 shows that this cable weighs approximately 0.25 pound per foot. Reference is required to the final unloaded sag charts 1 and 4 to obtain the permissible span lengths for 14 foot ground clearance at 60°F. on poles of various lengths.

5.03 The tabulation below compares the estimated costs, exclusive of small hardware, for strand and poles of various lengths required to give 14 foot ground clearance for the 0.25 pound per foot cable.

Sag and Span Data References	Sag Chart 1	Sag Chart 1	Sag Chart 4	Sag Chart 4
Strand size assumed	6M	6M	10M	10M
Pole length assumed	25 ft.	30 ft.	25 ft.	30 ft.
Pole setting depth	5 ft.	5.5 ft.	5 ft.	5.5 ft.
Maximum permissible sag	5 ft.	9.5 ft.	5 ft.	9.5 ft.
Maximum span for 14 foot clearance	300 ft.	380 ft.	390 ft.	550 ft.
Poles per mile	17.5	14.5	13.5	9.5
Pole class	7	7	7	7
Strand cost per mile, FOB	$320	$320	$400	$400
Pole cost per mile, in place	$300	$280	$230	$190
Pole and strand cost per mile	$620	$600	$630	$590

5.04 The tabulated data above shows that the span length could be 380 feet on 6M strand using 30 foot Class 7 poles or 550 feet on 10M strand, also on 30 foot Class 7 poles, both being at approximately the same cost per mile. Another factor to consider is whether the terrain or subscriber distribution favors a particular span length.

5.05 No concern need be given about an occasional span materially shorter than the adjacent spans except from the standpoint of the effect of short spans on the average spacing and, therefore, the number of poles needed. However, when an individual span occurs which is appreciably longer than the average span in its section of line, consideration should be given to the

question of proper limits for such spans before employing special construction. Special long span construction is recommended for such occasional spans when the length of the span in question is more than 50 percent greater than the average of five adjacent spans in either direction.

5.06 Long span construction may be necessary in aerial cable plant because of terrain characteristics that make construction of spans of normal length impracticable. An example is a river crossing. In such cases a long span must be designed to meet the particular situation. Long spans may involve catenary construction to avoid excessive sag on the span. The cable suspension strand fastened to the long span poles at a height to conform to required clearances can be supported at one or more points in the span by a catenary suspension strand. The catenary suspension strand is attached to these poles at a location above the cable strand. Separation between cable strand and catenary suspension strand at poles should be such as to allow span attachments to the catenary and support points to be in horizontal alignment. It usually is necessary to attach the catenary strand to the cable suspension strand by means of cable suspension hooks shown on Figure 1 so that the cable can be patrolled by a man in a cable car. The engineer must give consideration to the following factors:

a. Selection of a cable suspension strand which would be strong enough to support the cable without the catenary strand.

b. Selection of a catenary strand as strong or stronger than the cable suspension strand.

c. Selection of the suitable height and class of poles.

d. Pole setting depths required and their footings.

e. Side and head guy requirements.

5.07 In considering the design for long span construction excessive pole heights, excessive guying, unfavorable footings, etc., may prove more costly than other types of construction. Buried cable, cable in underground conduit or submarine cable may be considered. Figure 1 shows the general features of long span construction. When design problems involving special considerations arise, additional information may be obtained from REA.

5.08 Where other special construction is required such as slack spans, railroad crossings, bridge attachments, etc., the engineer shall design, obtain necessary permits and agreements, and prepare work plans for release to the staker and construction forces. See Figure 2 for slack span construction features. For railroad crossing construction requirements REA TE & CM-617 should be consulted.

6. CENTRAL OFFICE ENTRANCE CABLES

6.01 There are three methods of installing entrance cables which are aerial, buried or in underground conduit. The type of installation selected should depend on physical conditions and other circumstances. The engineer shall prepare detailed plans for this construction. Where clearance and appearance conditions are not controlling factors, aerial type entries should be satisfactory. However, if an underground entrance is required, cable may be buried directly in the ground or placed in underground conduit.

6.02 Where the buried entrance method is preferable and aerial cable made under REA Specification PE-22 is used predominately in the plant, this cable can be buried for central office entrances if the amount of buried cable does not exceed 400 feet. For greater amounts, cable made under REA Specification PE-23, "Fully Color-Coded, Polyethylene-Insulated, Double Polyethylene-Jacketed Telephone Cables for Direct Burial," should be used.

6.03 Where an underground conduit entrance is selected, due to the number of cables or some other reason, the entrance cables can be the REA Specification PE-22 plastic cable if the length needed is under 400 feet, or the REA Specification PE-23 plastic cable if the required length is greater than 400 feet. It is uneconomical to purchase short lengths of REA Specification PE-23 cable if the cable plant is to be predominately aerial using REA Specification PE-22 cable.

6.04 Lead-sheathed paper or pulp-insulated cable if used for underground entrances should be placed only in conduit. This cable where spliced to plastic-sheathed cable must use the splicing method described in paragraph 8.04.

6.05 Figures 3, 4, 5, and 6 illustrate the problems involved in engineering a central office entrance. B Type main distributing frames, which terminate the entrance cables on the

vertically mounted protectors, in the future will be provided with tip cables attached to the protector terminals at the factory. These tip cables must be spliced to the entrance cables either above the frames or in a splicing pit under the floor, the method to be selected by the engineer.

6.06 Where underground conduit entrances are planned, reference can be made to REA TE & CM-643 for details of such construction.

7. CABLE TERMINALS AND READY-ACCESS ENCLOSURES

7.01 Subscriber service drop wire connections to cable are provided for by devices of two general types. One type, called "terminal-aerial cable," is designed for use on lead or plastic-sheathed, paper or pulp-insulated aerial cables. This type is moistureproof with conductor connecting lugs accessible by lifting a non-watertight cover or lid. Another type called "ready-access enclosures," is designed for use on polyethylene-sheathed, polyethylene-insulated aerial cables. Both types of enclosures are available with or without a protector on each terminated conductor connecting lug. REA TE & CM-636 states the applications of terminals. These devices are items carried on pages P mm of the "List of Materials Acceptable for Use on Telephone Systems of REA Borrowers."

7.02 The determination of the locations, sizes and cable pair numbers to be terminated in each cable terminal will be shown on the staking sheets and as stated in REA TE & CM-629. It is customary to leave the connection of cable pairs to terminal blocks in ready-access enclosures to the telephone installation men.

8. AERIAL CABLE SPLICES

8.01 Splices in lead-sheathed paper or pulp-insulated cable can be made by wiped joints in accordance with REA Specification PC-1 dated October 1955, but the preferred method is by the use of splice cases. Two "splice cases" of the same kind are required to make a splice enclosure. These devices are carried on pages P pl of the "List of Materials Acceptable for Use on Telephone Systems of REA Borrowers" and are available in four sizes for straight splices. They are for cables

1.0 inch maximum diameter, 1.0 to 1.6 inches in diameter, 1.6 to 2.2 inches in diameter, and 2.2 to 2.9 inches in diameter.

8.02 Three sizes of splice cases are available for splicing branch cables to main cables. These have two entrance nozzles at each end. They are made for cables 1.0 inch maximum diameter, 1.0 to 2.2 inches in diameter, and 2.2 to 2.8 inches in diameter. If the splice is to be three-way, the fourth nozzle is plugged with a plastic insert. The two splice cases are bolted together with a plastic sealing cord between the two cases. Each splice case has a lug at its left end protruding upward for clamping the complete enclosure to the suspension strand.

8.03 Splices in aerial polyethylene-insulated, polyethylene-jacketed cable should be made in accordance with REA Specification PC-2. This specification requires the use of ready-access enclosures.

8.04 Situations will arise where aerial polyethylene-insulated, polyethylene-jacketed cable must be spliced to paper or pulp-insulated (Alpeth or Stalpeth) plastic-jacketed or lead-sheathed cable. The wire splicing in these cases can be performed as described in REA Specification PC-3. Mounting of the splice cases can be performed in accordance with the instructions provided with the splice cases by the manufacturer.

9. SAG, HILLSIDE AND LEVEL GROUND

9.01 Determination of the location and amount of the sag at the low point in hillside situations and river crossings where support points on poles will not be at the same elevation can be made as indicated on Figure 7.

9.02 Sag values in percent of midspan sag of level spans at points along a span can be determined from Figure 8. This information may be found useful in determining separations when clearances in a span are involved.

CABLE SIZES, WEIGHTS AND REEL LENGTHS

NUMBER of Pairs	APPROX. DIA IN INCHES AND WEIGHT PER FOOT IN POUNDS								APPROX. REEL LENGTHS			
	26		24		22		19		26	24	22	19
	In.	Lbs.	In.	Lbs.	In.	Lbs.	In.	Lbs.	Ft.	Ft.	Ft.	Ft.
Lead Sheathed Cables												
6	-	-	-	-	-	-	.4	.4	-	-	-	2800
11	.3	.3	.4	.3	.4	.4	.5	.6	3500	3300	3500	3000
16	.4	.3	.4	.4	.5	.5	.6	.7	3300	2900	3500	4000
26	.4	.4	.5	.5	.6	.6	.7	.9	4000	4500	4200	3000
51	.5	.6	.6	.7	.7	.9	1.0	1.5	4200	4200	3000	2500
76	.6	.7	.7	.9	.9	1.2	1.2	2.0	3700	3000	2400	2200
101	.7	.8	.8	1.1	1.0	1.5	1.3	2.5	3500	3000	3000	1700
152	.8	1.1	.9	1.4	1.2	2.0	1.6	3.4	2400	2800	1700	1400
202	.9	1.3	1.1	1.7	1.3	2.5	1.8	4.3	2500	2200	1600	1400
303	1.1	1.8	1.2	2.3	1.6	3.5	2.2	6.0	1600	1600	1400	900
404	1.2	2.2	1.4	2.9	1.8	4.3	2.5	7.7	1600	1400	1200	700
455	-	-	-	-	-	-	2.6	8.5	-	-	-	650
606	1.4	2.9	1.7	4.0	2.2	6.0	-	-	1400	1100	900	-
Plastic Sheathed Cables - Paper or Pulp Insulated												
6	-	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	.6	.18	-	-	-	-
16	-	-	-	-	.6	.15	.7	.2	-	-	3500	4000
26	-	-	-	-	.7	.2	.8	.3	-	-	4200	3000
51	.6	.15	.7	.2	.8	.3	1.1	.6	-	4200	3000	2500
76	.7	.2	.8	.3	1.0	.5	1.3	.9	-	3000	2400	2200
101	.8	.3	.9	.4	1.1	.6	1.5	1.2	-	3000	3000	1700
152	.9	.4	1.1	.6	1.3	.9	1.7	1.7	-	2800	1700	1400
202	1.0	.5	1.2	.8	1.5	1.2	1.9	2.2	-	2200	1600	1400
303	1.2	.8	1.4	1.1	1.7	1.7	2.3	3.2	-	1600	1400	900
404	1.4	1.0	1.6	1.4	1.9	2.2	2.7	4.3	-	1400	1200	-
455	-	-	-	-	2.1	2.6	2.8	4.8	-	1100	-	800
606	1.6	1.4	1.9	2.1	2.3	3.2	-	-	-	900	1000	-
Plastic Sheathed and Plastic Insulated Cables												
6	-	-	.40	.08	.45	.11	.53	.15	5000	5000	5000	5000
12	-	-	.47	.12	.54	.15	.65	.25	5000	5000	5000	5000
18	-	-	.52	.15	.60	.21	.75	.33	5000	5000	5000	5000
25	-	-	.57	.18	.67	.26	.87	.46	3000	5000	5000	5000
50	-	-	.70	.31	.86	.44	1.14	.83	3000	3000	3000	2500
75	-	-	.82	.42	.99	.61	1.33	1.14	3000	3000	3000	2500
100	-	-	.91	.53	1.14	.82	1.51	1.45	3000	3000	3000	2500
150	-	-	1.07	.78	1.32	1.11	1.82	2.22	3000	3000	3000	1000
200	-	-	1.20	.98	1.51	1.50	2.08	2.75	1000	1000	1000	1000
300	-	-	1.43	1.40	1.84	2.26	2.48	3.89	1000	1000	1000	1000
400	-	-	1.64	1.77	2.07	2.76	2.83	4.95	1000	1000	1000	1000

Table 1

LONG SPAN CONSTRUCTION
GENERAL CONSTRUCTION FEATURES.

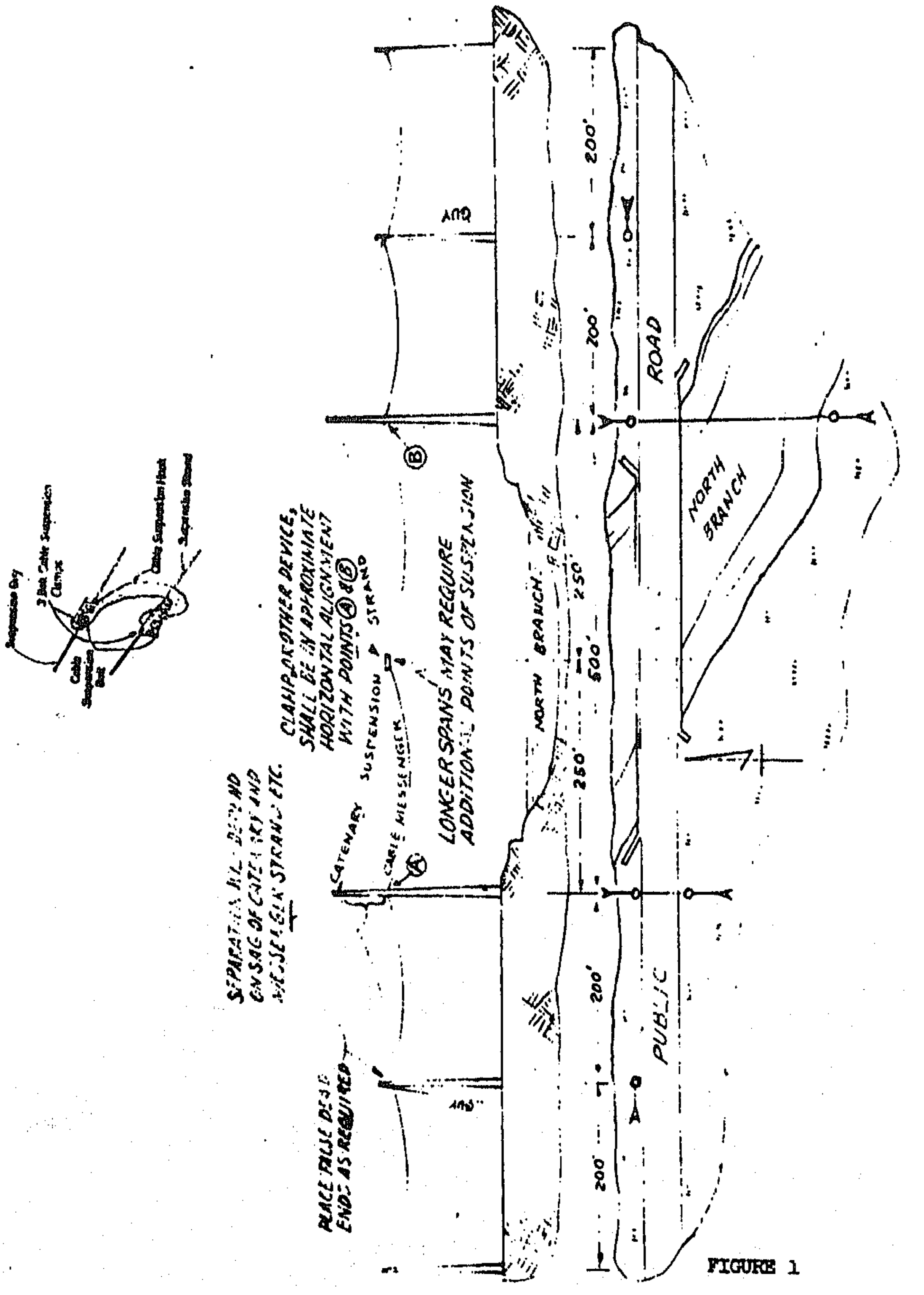
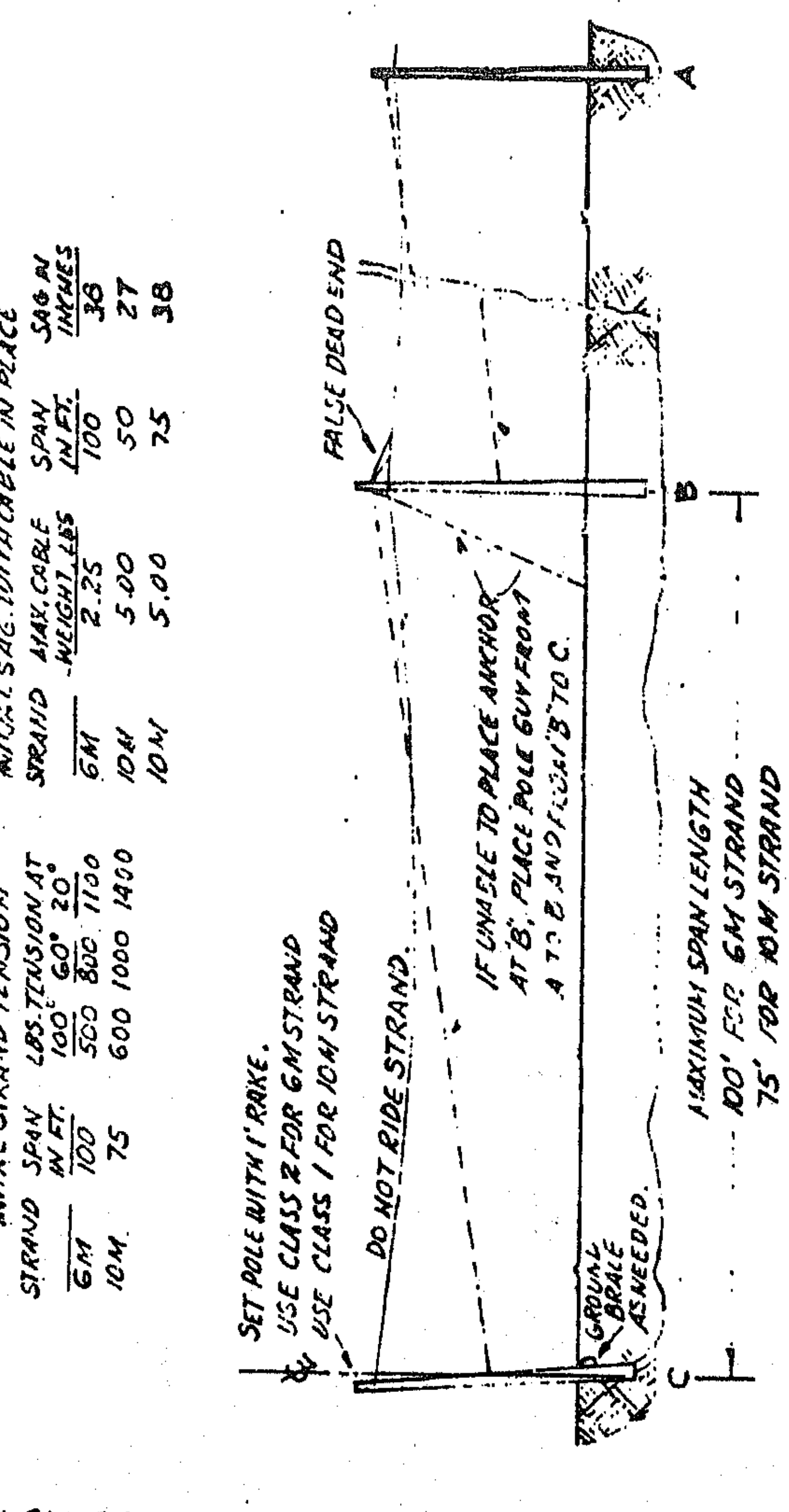


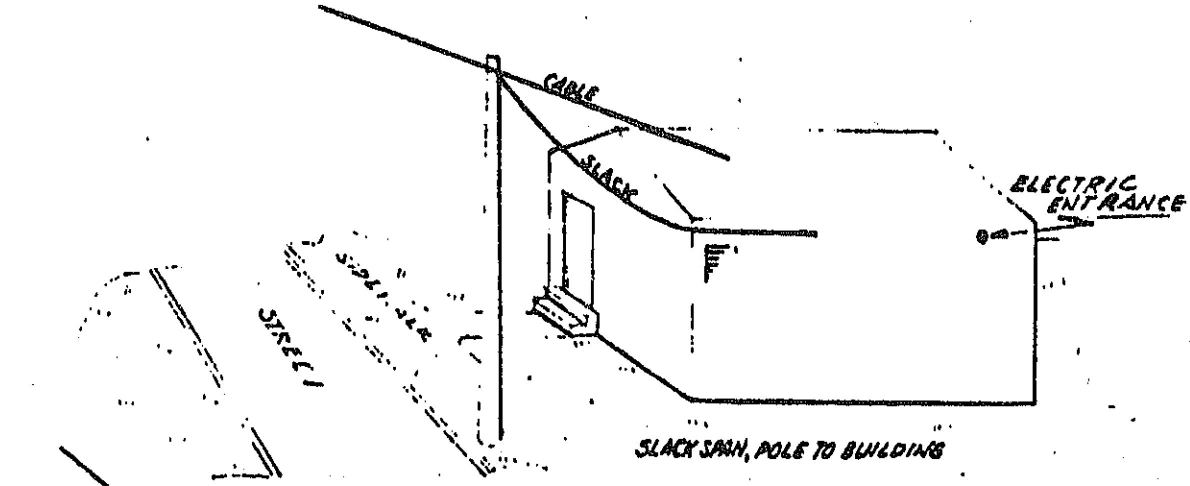
FIGURE 1



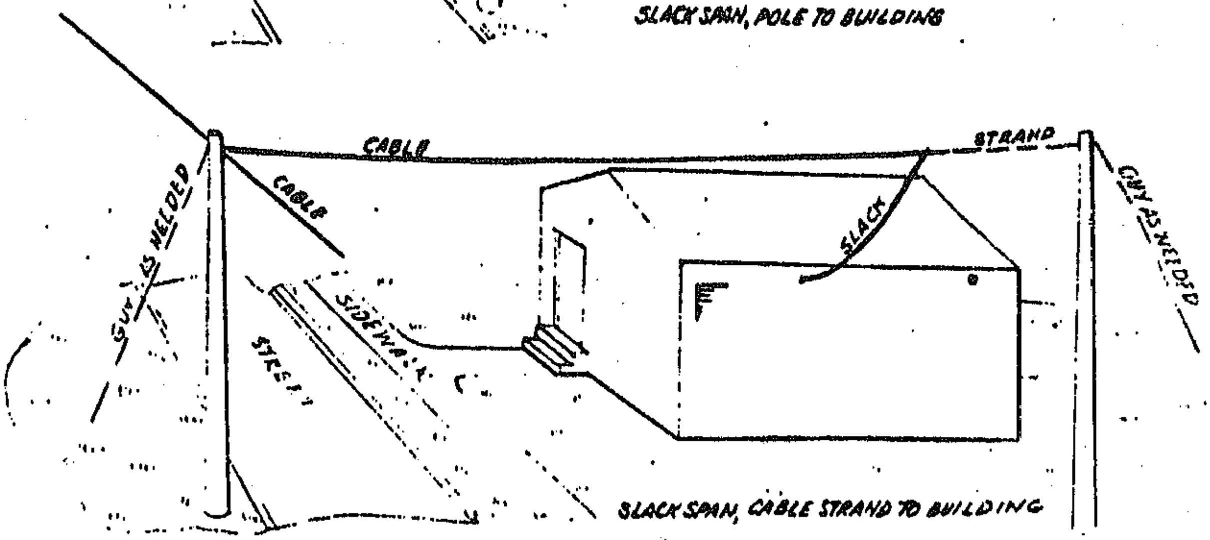
SLACK SPAN CONSTRUCTION

FIGURE 2

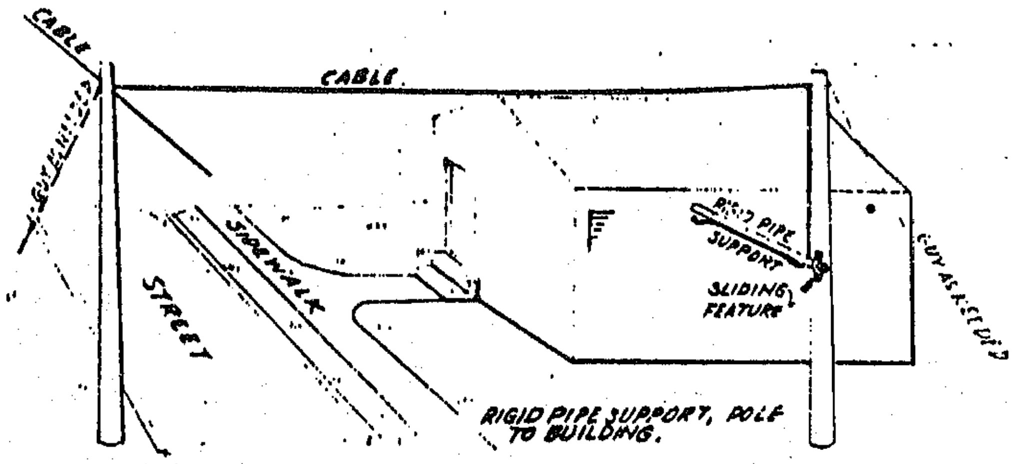
METHODS OF AERIAL CONSTRUCTION IN APPROACH TO CENTRAL OFFICE ENTRANCE



SLACK SPAN, POLE TO BUILDING



SLACK SPAN, CABLE STRAND TO BUILDING



RIGID PIPE SUPPORT, POLE TO BUILDING.

NOTE: JOINT USE CONSTRUCTION SHALL CONFORM TO TE & CM 690

FIGURE 3

ENTRANCES FOR SMALL OFFICES

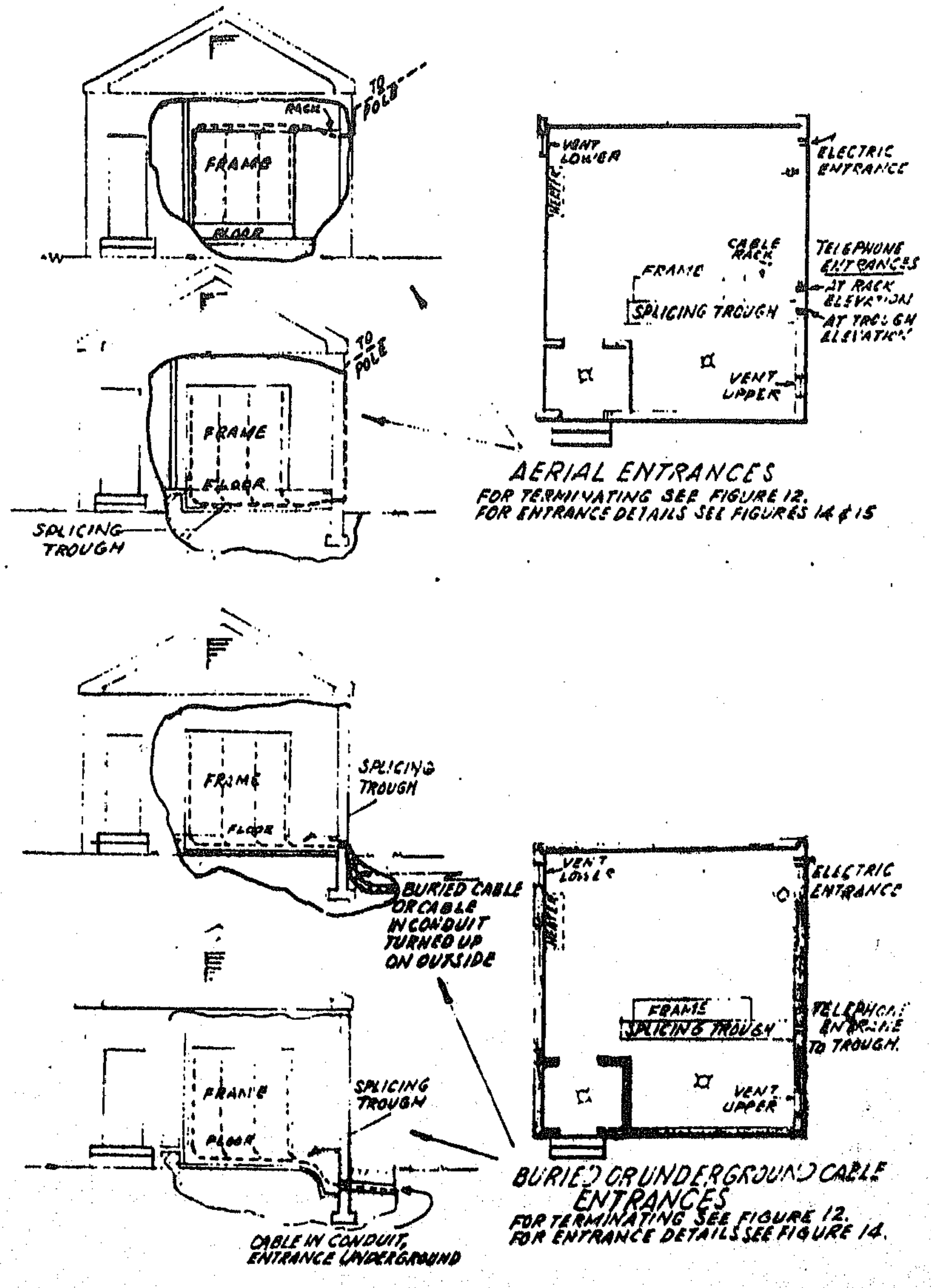


FIGURE 4

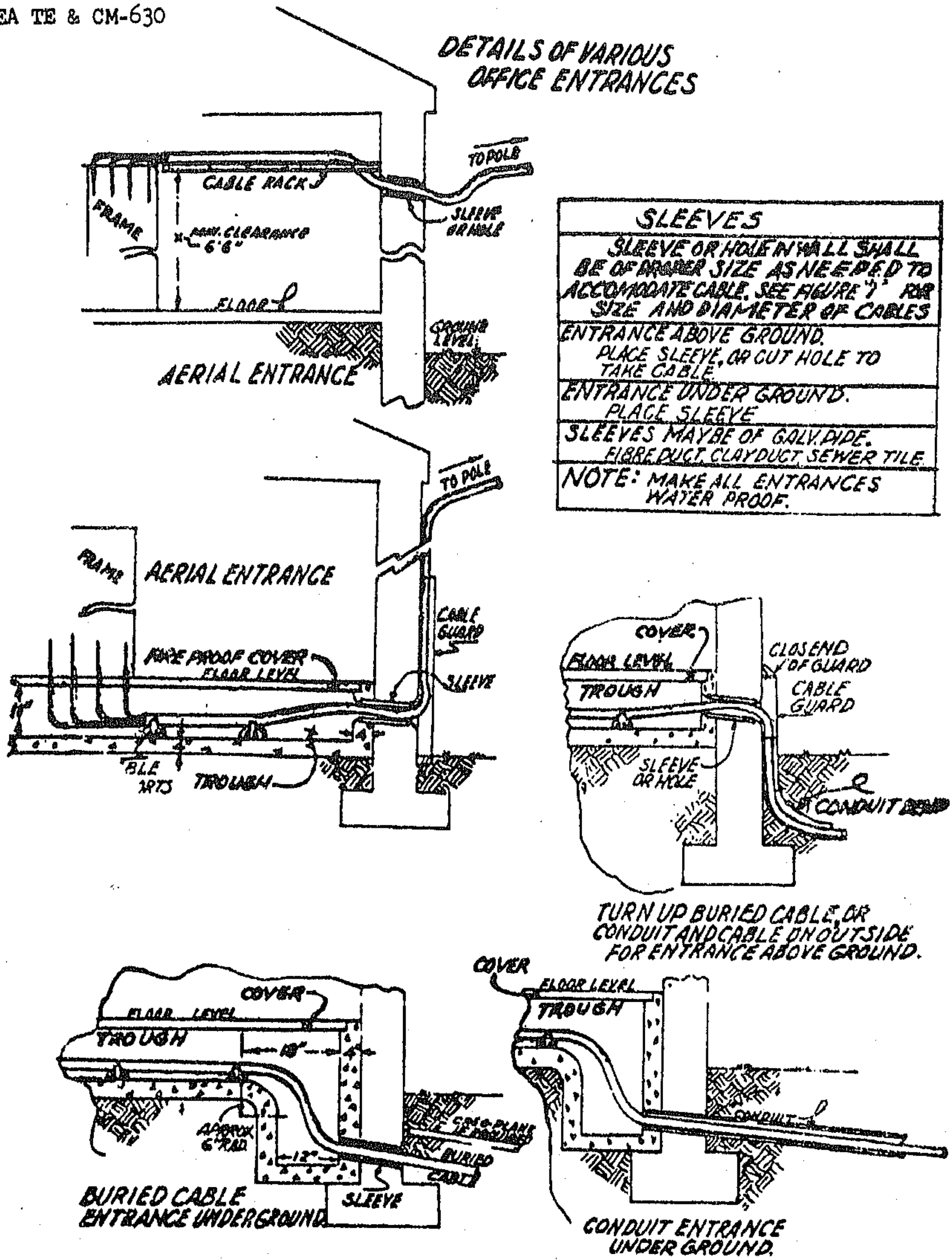
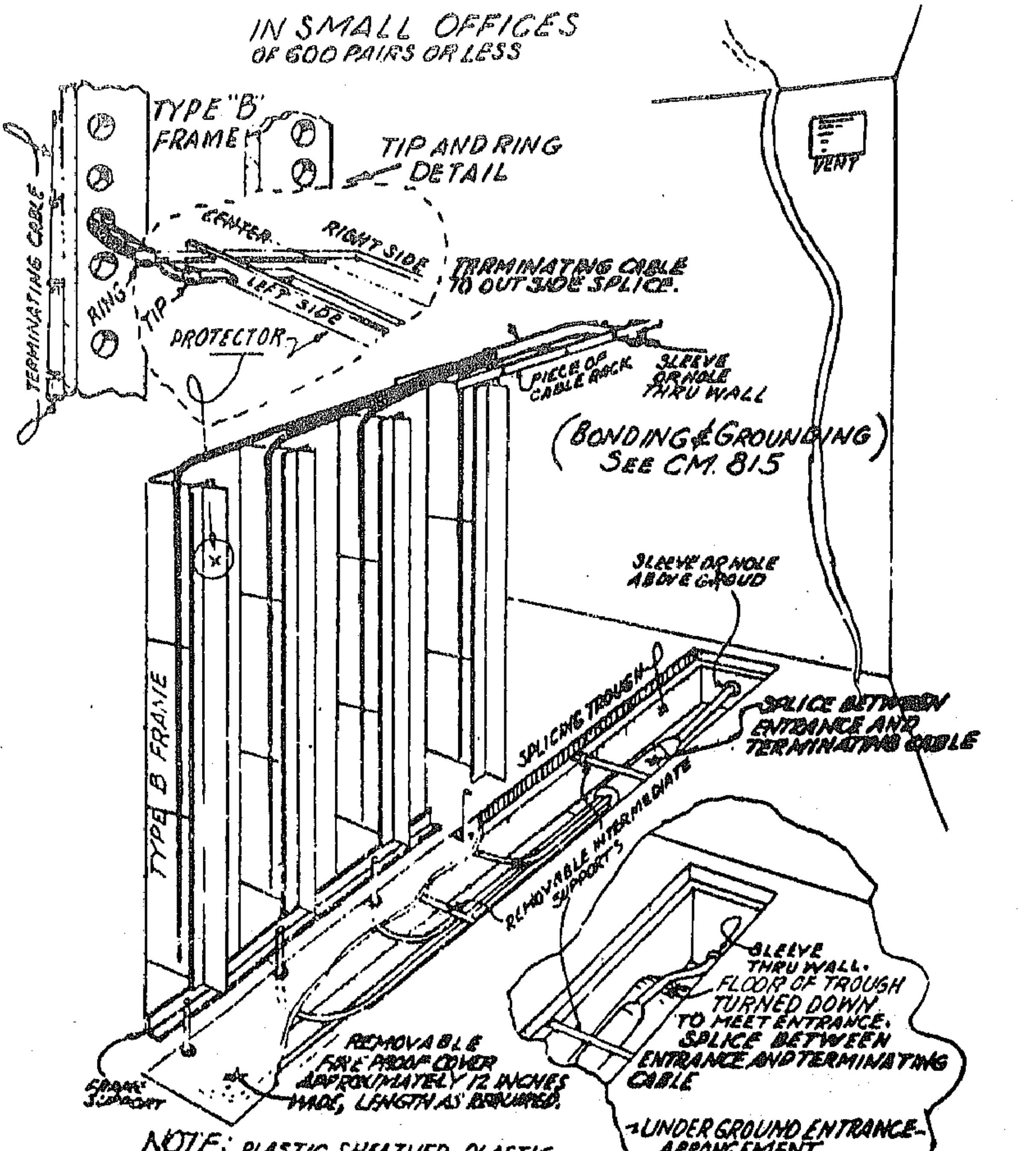

DETAILS OF VARIOUS
OFFICE ENTRANCES
TO POLE
CABLE RACK
FRAME
SLEEVE OR HOLE
FLOOR
GROUND LEVEL
AERIAL ENTRANCE
SLEEVES
SLEEVE OR HOLE IN WALL SHALL BE OF PROPER SIZE AS NEEDED TO ACCOMMODATE CABLE. SEE FIGURE "1" FOR SIZE AND DIAMETER OF CABLES
ENTRANCE ABOVE GROUND.
PLACE SLEEVE, OR CUT HOLE TO TAKE CABLE.
ENTRANCE UNDER GROUND.
PLACE SLEEVE
SLEEVES MAYBE OF GALV. PIPE. FIBRE DUCT, CLAY DUCT, SEWER TILE.
NOTE: MAKE ALL ENTRANCES WATER PROOF.
TO POLE
FRAME
AERIAL ENTRANCE
CABLE GUARD
FIRE PROOF COVER
FLOOR LEVEL
SLEEVE
TROUGH
COVER
FLOOR LEVEL
TROUGH
CLOS END OF GUARD
CABLE GUARD
SLEEVE OR HOLE
CONDUIT
TURN UP BURIED CABLE, OR CONDUIT AND CABLE ON OUTSIDE FOR ENTRANCE ABOVE GROUND.
COVER
FLOOR LEVEL
TROUGH
18"
APPROX 6" RAD.
12"
BURIED CABLE
SLEEVE
BURIED CABLE ENTRANCE UNDERGROUND
COVER
FLOOR LEVEL
TROUGH
CONDUIT
CONDUIT ENTRANCE UNDER GROUND.

Figure 5

METHODS OF TERMINATING
IN SMALL OFFICES
OF 600 PAIRS OR LESS



NOTE: PLASTIC SHEATHED-PLASTIC INSULATED CABLE.

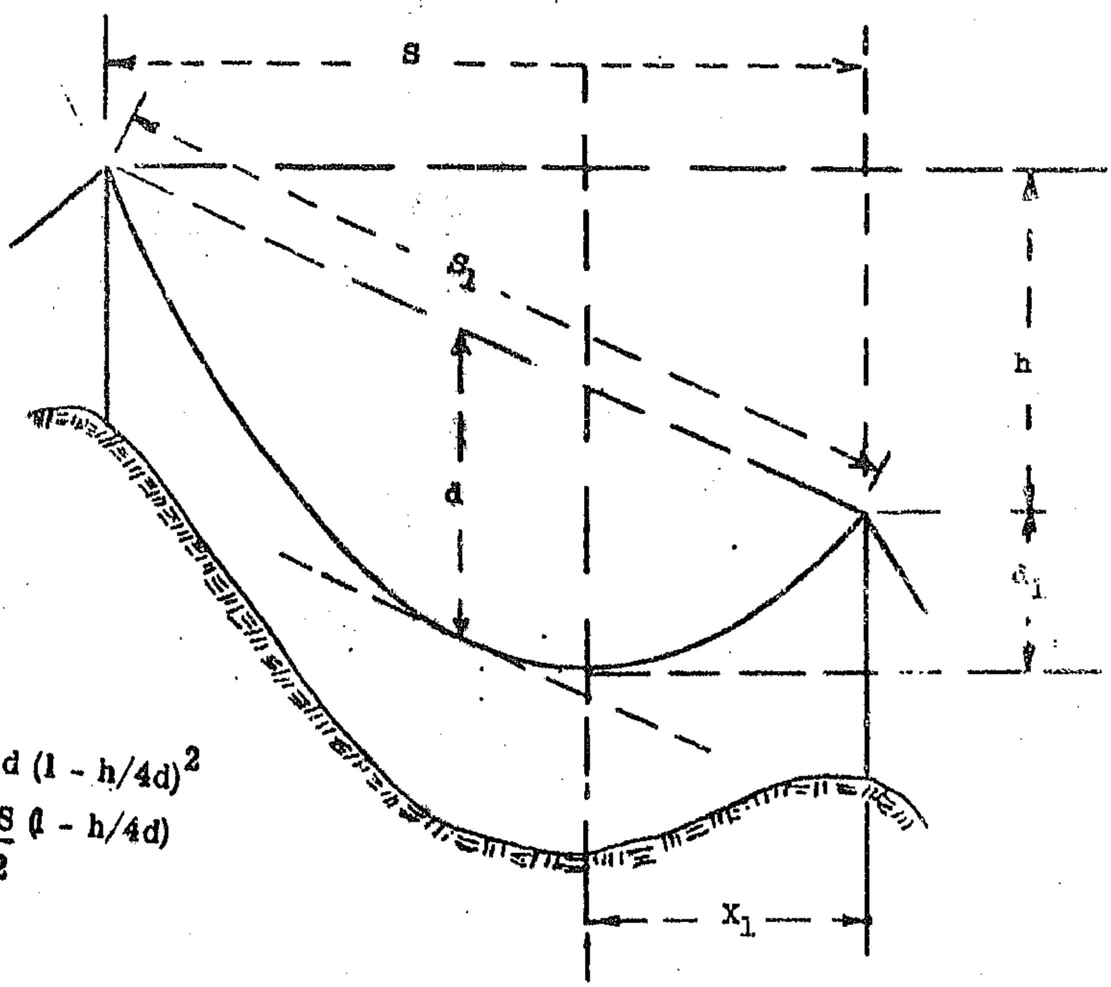
WHEN THE ENTRANCE IS THIS TYPE OF CABLE IT MAY BE CONTINUED TO THE FRAME AND TERMINATED.

IN SOLDERING THE CABLE CONDUCTORS TO THE LUGS ON THE FRAME, USE CARE TO AVOID DAMAGE TO THE PLASTIC INSULATION.

TO MAINTAIN POLARITY: ON "A" TYPE FRAMES, TERMINATE SO THAT TRACER (RING) CONDUCTOR OF PAIR SHALL BE ON RIGHT HAND LUG OF PAIR WHEN LUGS ARE STAGGERED, OR ON BACK LUG OF PAIR WHEN LUGS ARE IN LINE.

ON "B" TYPE FRAMES, TERMINATE TRACER (RING) CONDUCTOR OF PAIR ON LUG LEADING TO RIGHT HAND SIDE OF PROTECTOR.

FIGURE 6



$d_1 = d\,(1 - h/4d)^2$

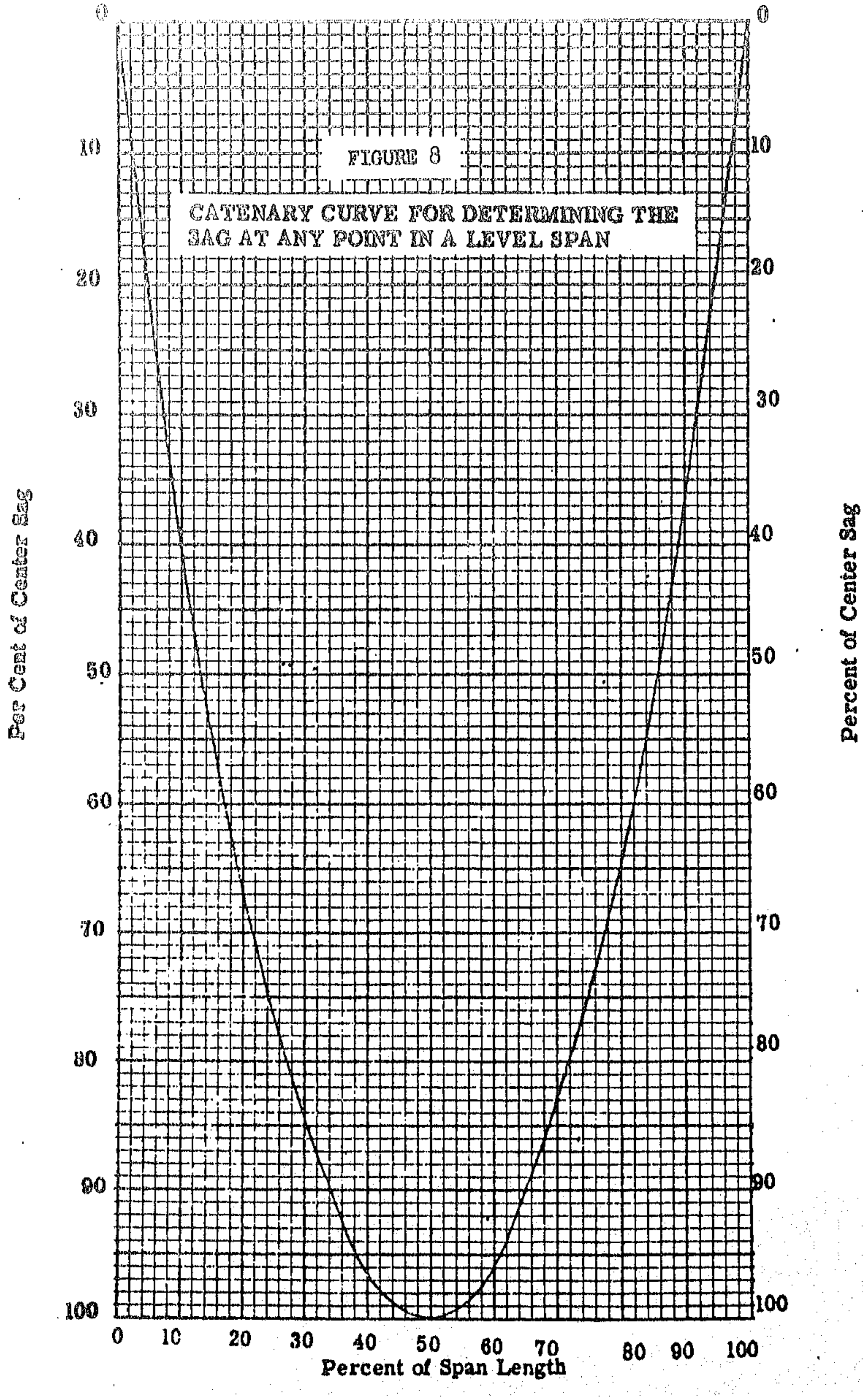
$x_1 = \frac{S}{2}\,(1 - h/4d)$

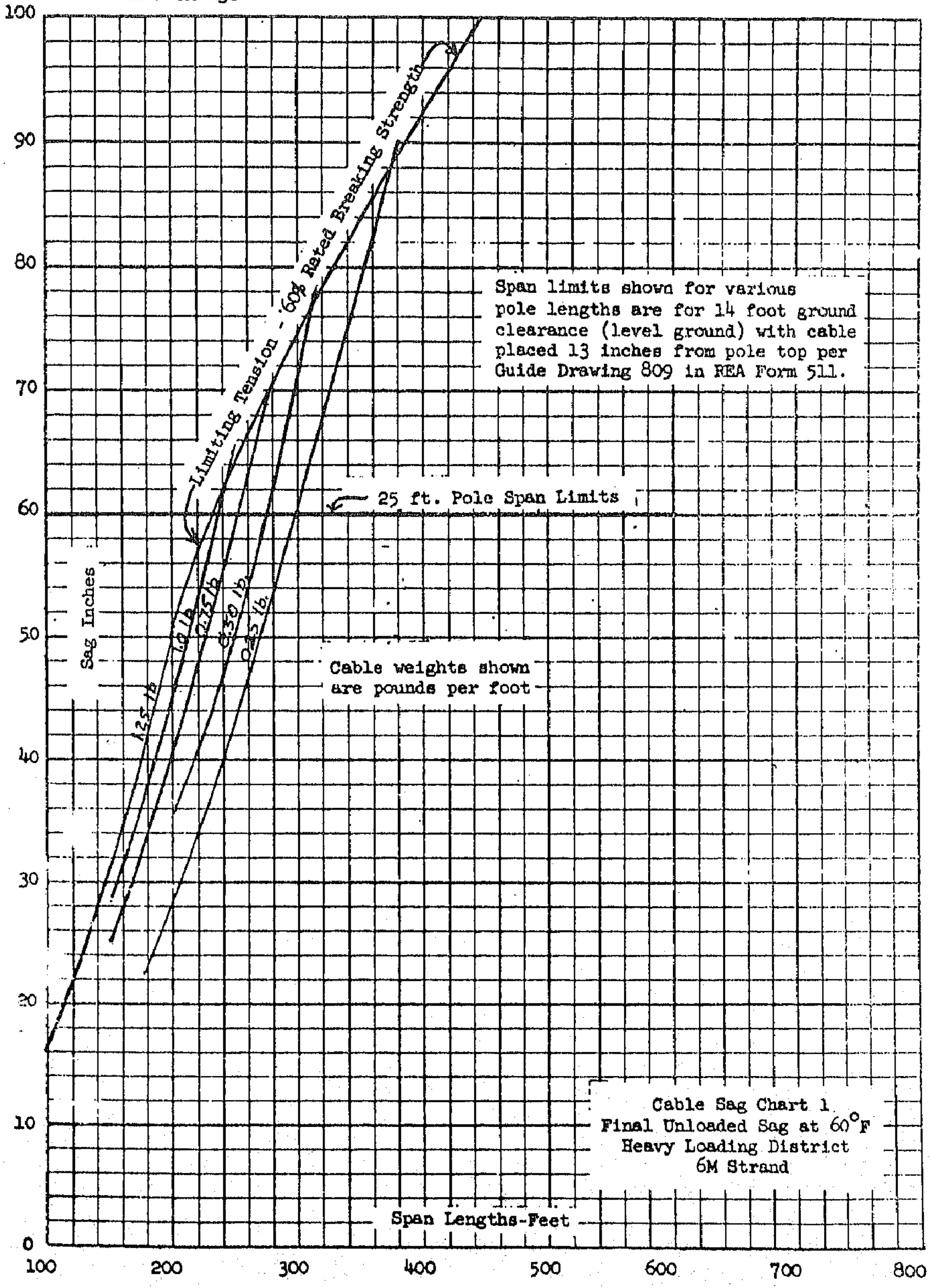
DETERMINATION OF THE MAXIMUM SAG POINT

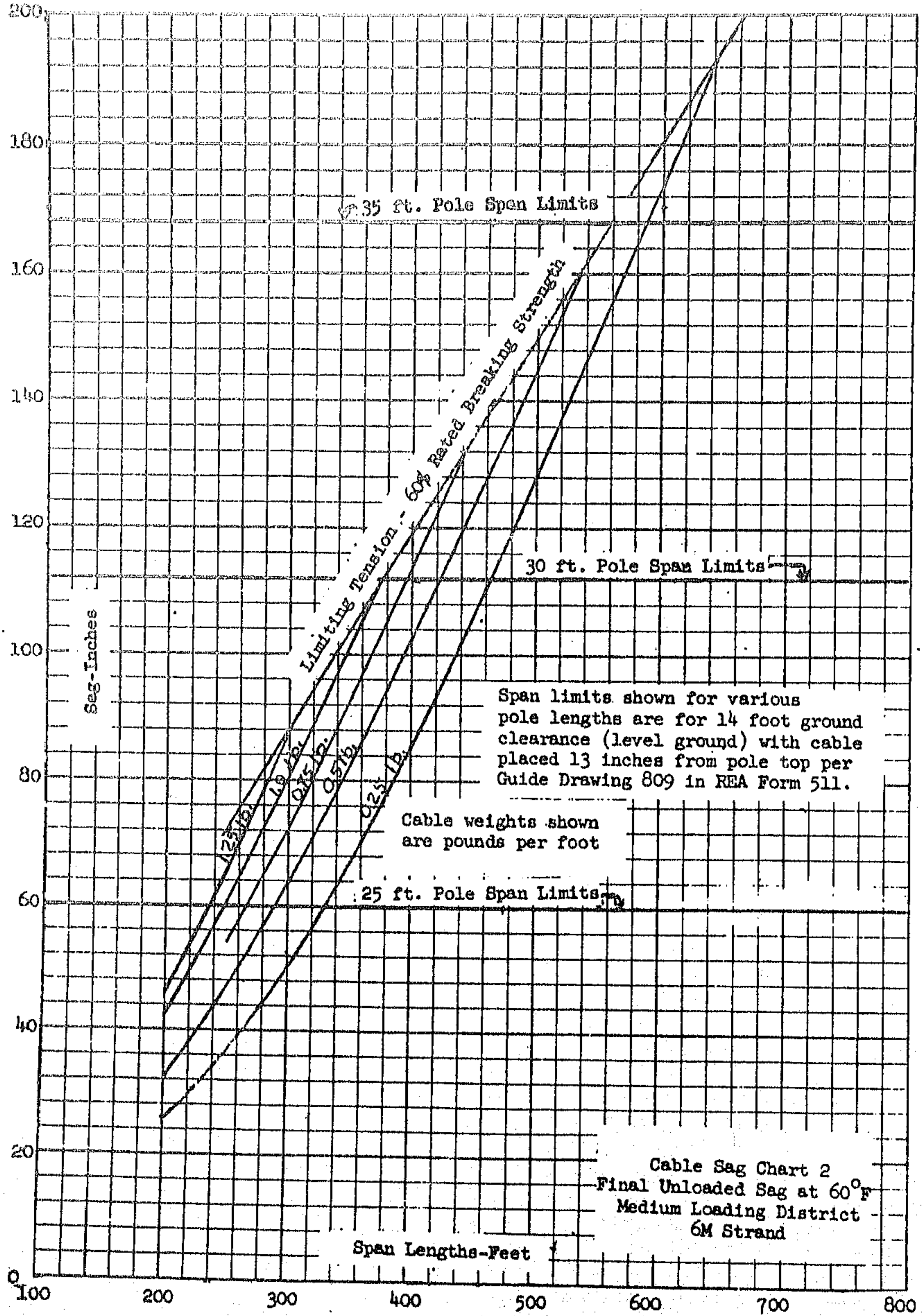
FIGURE 7

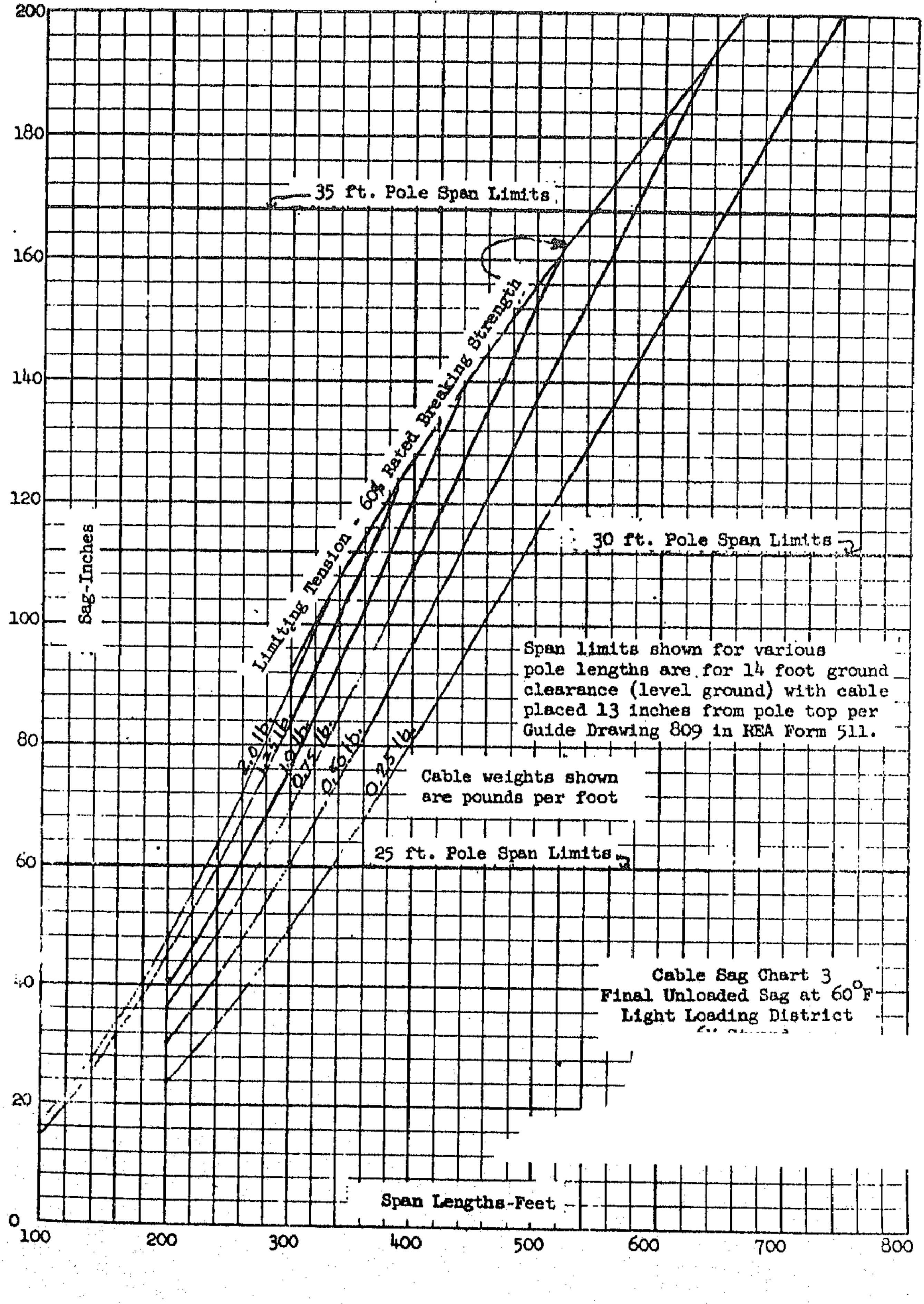
FIGURE 8

CATENARY CURVE FOR DETERMINING THE SAG AT ANY POINT IN A LEVEL SPAN

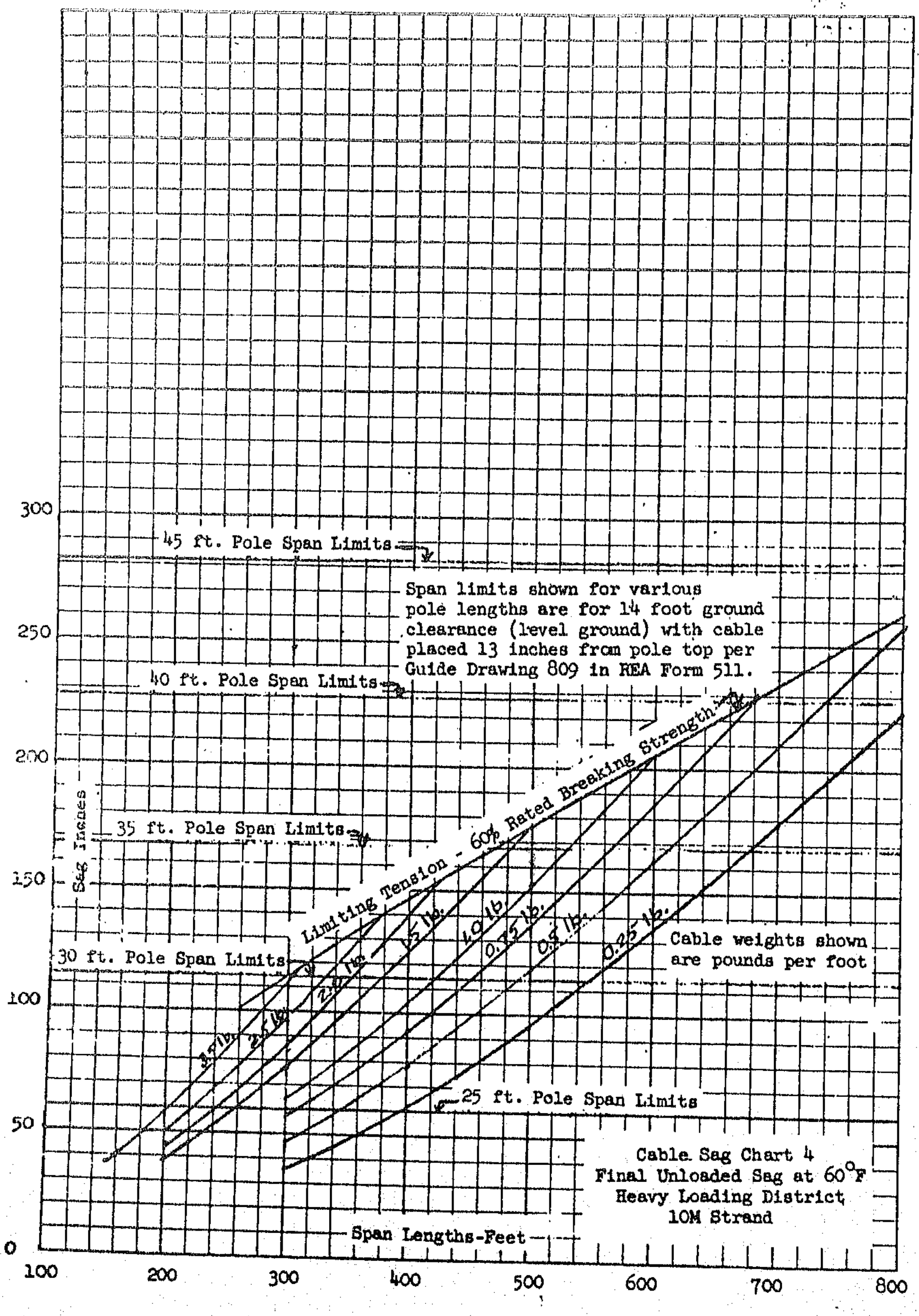



100
90
80
70
60
50
40
30
20
10
0
Sag Inches
Limiting Tension - 60% Rated Breaking Strength
Span limits shown for various pole lengths are for 14 foot ground clearance (level ground) with cable placed 13 inches from pole top per Guide Drawing 809 in REA Form 511.
25 ft. Pole Span Limits
1.25 lb
1.0 lb
0.75 lb
0.50 lb
0.25 lb
Cable weights shown are pounds per foot
Cable Sag Chart 1
Final Unloaded Sag at 60°F
Heavy Loading District
6M Strand
Span Lengths-Feet
100
200
300
400
500
600
700
800

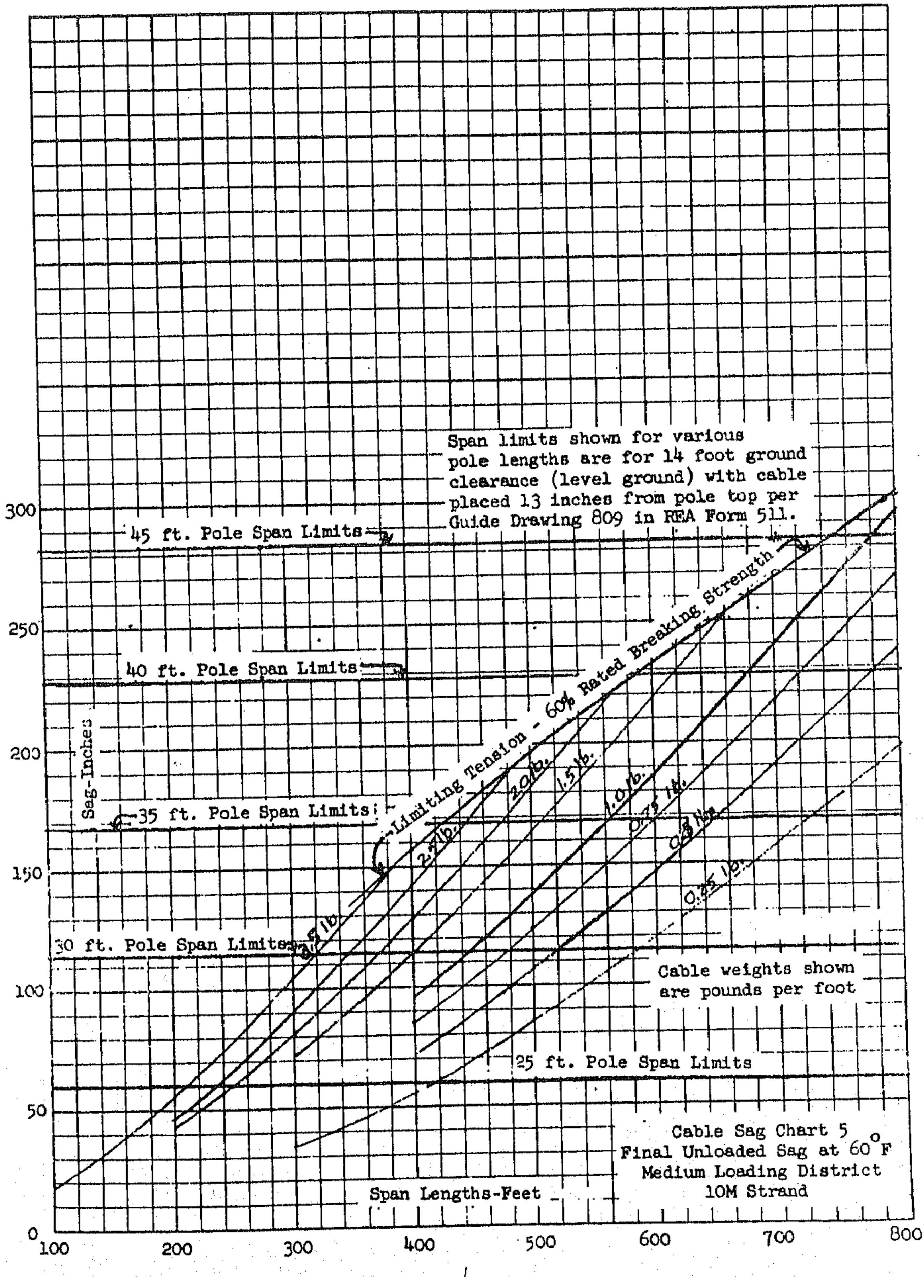

35 ft. Pole Span Limits
Limiting Tension - 60% Rated Breaking Strength
30 ft. Pole Span Limits
25 ft. Pole Span Limits
1.25 lb.
1.0 lb.
0.75 lb.
0.5 lb.
0.25 lb.
Span limits shown for various pole lengths are for 14 foot ground clearance (level ground) with cable placed 13 inches from pole top per Guide Drawing 809 in REA Form 511.
Cable weights shown are pounds per foot
Sag-Inches
Span Lengths-Feet
Cable Sag Chart 2
Final Unloaded Sag at 60°F
Medium Loading District
6M Strand
0
20
40
60
80
100
120
140
160
180
200
100
200
300
400
500
600
700
800

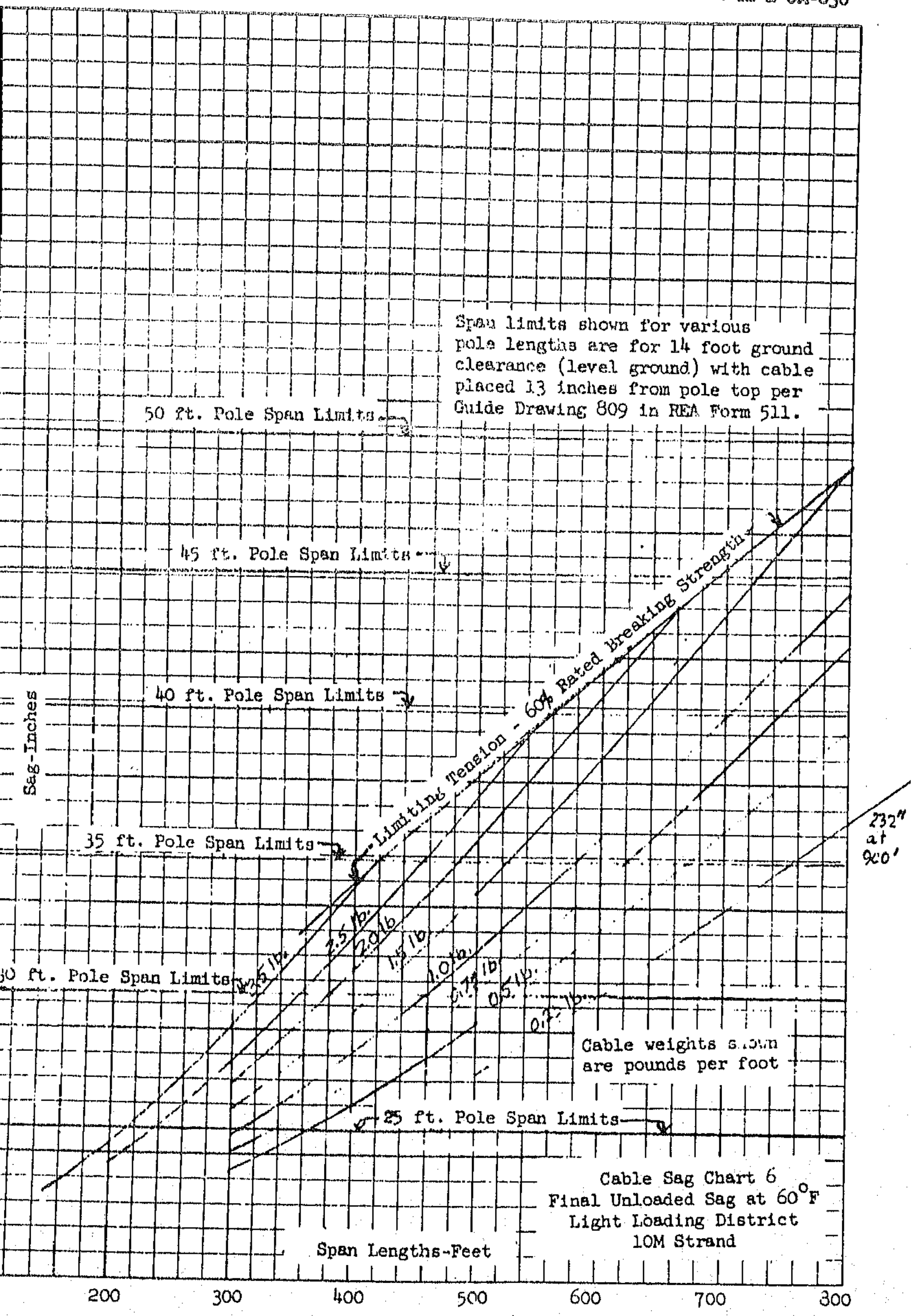


Sag-Inches
Span Lengths-Feet
0
20
40
60
80
100
120
140
160
180
200
100
200
300
400
500
600
700
800
35 ft. Pole Span Limits
30 ft. Pole Span Limits
25 ft. Pole Span Limits
Limiting Tension - 60% Rated Breaking Strength
2.0 lb.
1.5 lb.
1.0 lb.
0.75 lb.
0.50 lb.
0.25 lb.
Span limits shown for various pole lengths are for 14 foot ground clearance (level ground) with cable placed 13 inches from pole top per Guide Drawing 809 in REA Form 511.
Cable weights shown are pounds per foot
Cable Sag Chart 3
Final Unloaded Sag at 60°F
Light Loading District

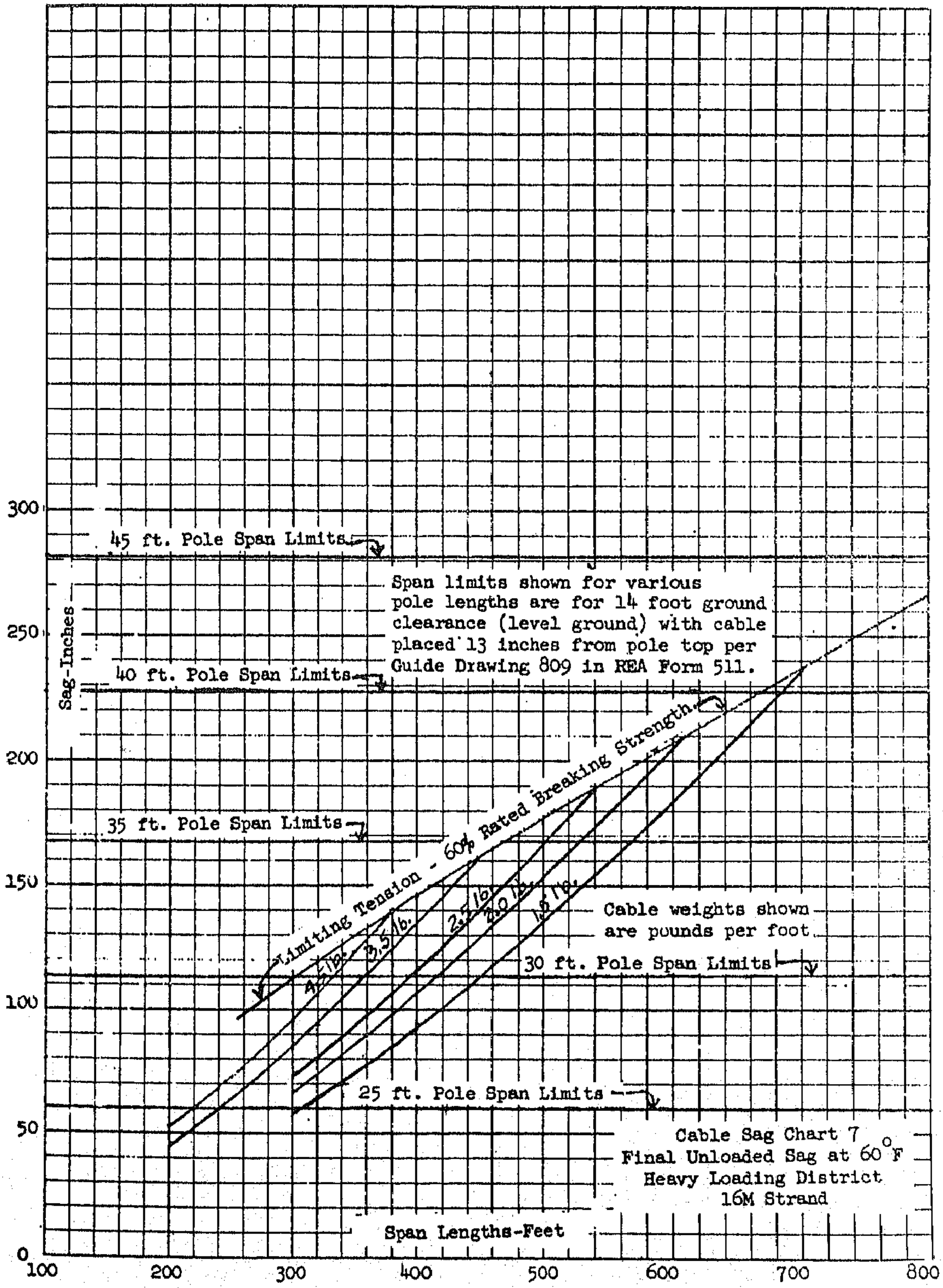


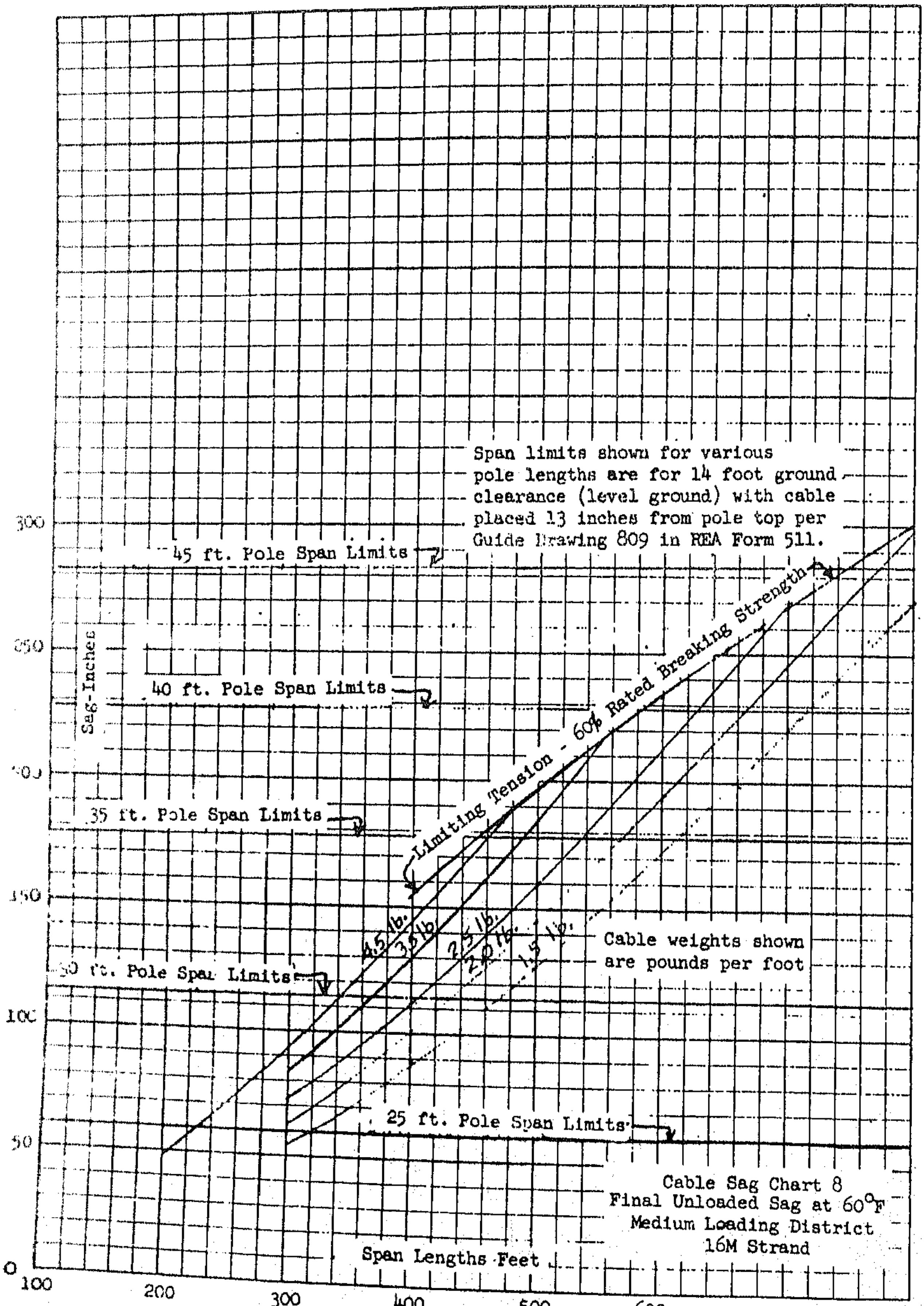
300
250
200
150
100
50
0
Sag Inches
45 ft. Pole Span Limits
Span limits shown for various pole lengths are for 14 foot ground clearance (level ground) with cable placed 13 inches from pole top per Guide Drawing 809 in REA Form 511.
40 ft. Pole Span Limits
35 ft. Pole Span Limits
Limiting Tension - 60% Rated Breaking Strength
30 ft. Pole Span Limits
Cable weights shown are pounds per foot
1.5 lb.
1.0 lb.
0.75 lb.
0.5 lb.
0.25 lb.
2.0 lb.
2.5 lb.
3.0 lb.
25 ft. Pole Span Limits
Cable Sag Chart 4
Final Unloaded Sag at 60°F
Heavy Loading District
10M Strand
Span Lengths-Feet
100
200
300
400
500
600
700
800


Span limits shown for various pole lengths are for 14 foot ground clearance (level ground) with cable placed 13 inches from pole top per Guide Drawing 809 in REA Form 511.
45 ft. Pole Span Limits
40 ft. Pole Span Limits
35 ft. Pole Span Limits
30 ft. Pole Span Limits
25 ft. Pole Span Limits
Limiting Tension - 60% Rated Breaking Strength
Sag-Inches
2.7 lb.
2.0 lb.
1.5 lb.
1.0 lb.
0.75 lb.
0.25 lb.
Cable weights shown are pounds per foot
Span Lengths-Feet
0
50
100
150
200
250
300
100
200
300
400
500
600
700
800
Cable Sag Chart 5
Final Unloaded Sag at 60°F
Medium Loading District
10M Strand

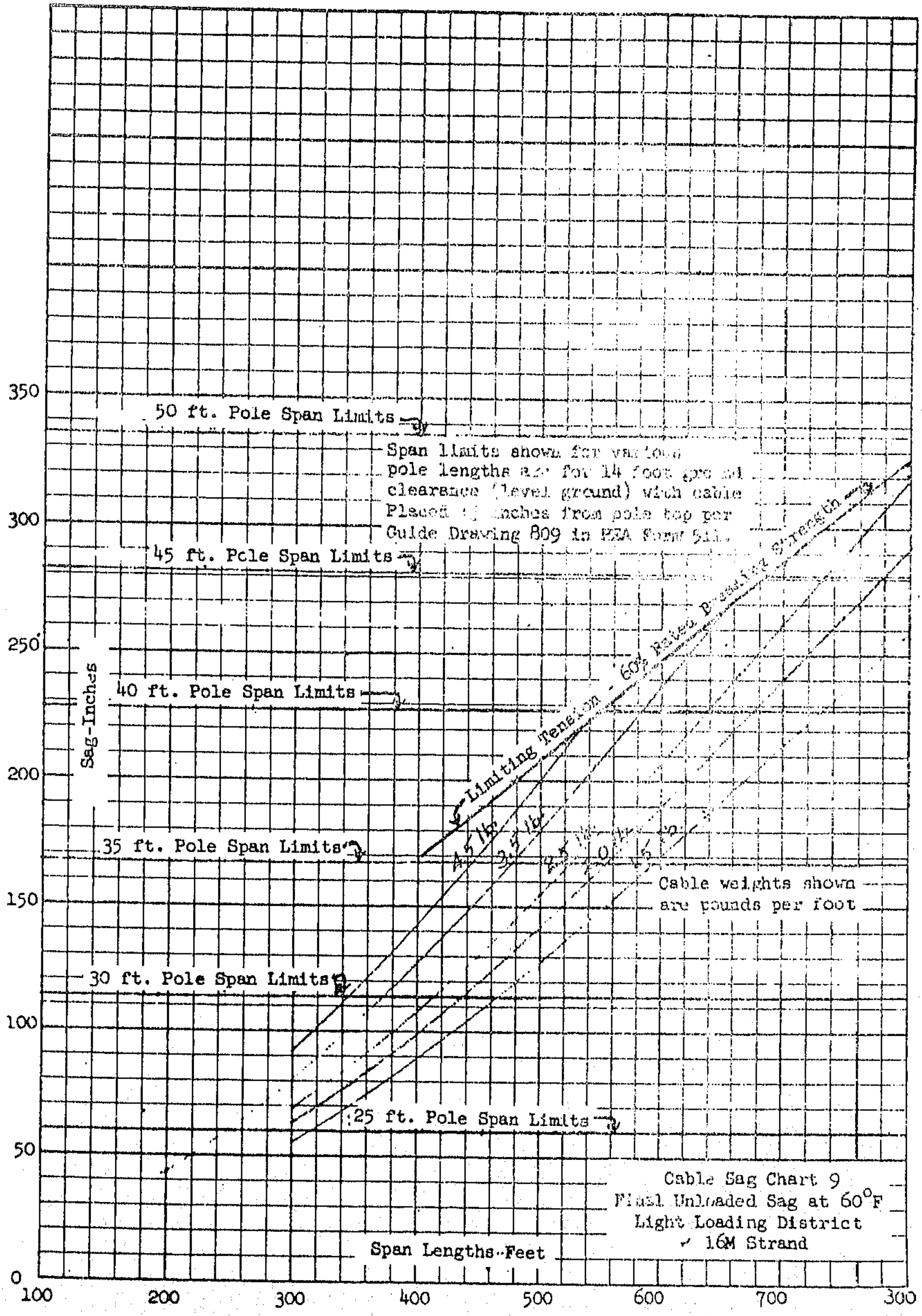


Cable Sag Chart 6
Final Unloaded Sag at 60°F
Light Loading District
10M Strand


45 ft. Pole Span Limits
Span limits shown for various pole lengths are for 14 foot ground clearance (level ground) with cable placed 13 inches from pole top per Guide Drawing 809 in REA Form 511.
40 ft. Pole Span Limits
Limiting Tension - 60% Rated Breaking Strength
35 ft. Pole Span Limits
Cable weights shown are pounds per foot
30 ft. Pole Span Limits
25 ft. Pole Span Limits
Cable Sag Chart 7
Final Unloaded Sag at 60°F
Heavy Loading District
16M Strand
Sag-Inches
Span Lengths-Feet
0
50
100
150
200
250
300
100
200
300
400
500
600
700
800



Cable Sag Chart 8
Final Unloaded Sag at 60°F
Medium Loading District
16M Strand


50 ft. Pole Span Limits
Span limits shown for various pole lengths are for 14 foot ground clearance (level ground) with cable Placed inches from pole top per Guide Drawing 809 in REA Form 511.
45 ft. Pole Span Limits
Limiting Tension - 60% Rated Breaking Strength
40 ft. Pole Span Limits
Sag-Inches
35 ft. Pole Span Limits
4.5 lb
3.5 lb
2.5 lb
1.0 lb
.5 lb
Cable weights shown are pounds per foot
30 ft. Pole Span Limits
25 ft. Pole Span Limits
Cable Sag Chart 9
Final Unloaded Sag at 60°F
Light Loading District
16M Strand
Span Lengths-Feet
0
50
100
150
200
250
300
350
100
200
300
400
500
600
700
800